WATER RESOURCES

Water Supply

Water sources within the basin include the natural flow of the Payette River and its tributaries, lakes and storage projects, ground water, springs, and return flows. Annual precipitation, timing of runoff, water quality, water allocation, and current water use all affect the water supply and potential water use in the basin.

Based on an average annual precipitation of 30 inches, the annual average volume of water entering the Payette River Basin is 5.3 million acre-feet (Warnick, et al., 1981b). The volume of water leaving the basin is assumed to be the discharge of the Payette River at its mouth. Annual average discharge of the Payette River at the U.S. Geological Survey gage near the city of Payette is 2.2 million acre-feet (Table 9). The difference between the annual volume of precipitation and measured outflow, 3.1 million acre-feet per year, is used or lost through evapotranspiration by native vegetation or crops, evaporation from open water and bare ground, sublimation of snow, or ground water recharge. Some ground water leaves the basin as discharge to the Snake River below and above the Payette River confluence (Deick and Ralston, 1986).

SURFACE WATER

The majority of Payette River Basin runoff originates as snow melt from the upper watershed above Banks. Average annual runoff of the Payette River at Horseshoe Bend is about 2.35 million acre-feet of water per year, based on the 77-year record from 1920 to 1997. The maximum recorded runoff at Horseshoe Bend was 3.8 million acre-feet in 1974 and the minimum was 1.06 million acre-feet in 1931. Payette River runoff at its mouth is slightly less than runoff recorded at Horseshoe Bend, 60 miles upstream. Diversions for consumptive use below Horseshoe Bend reduce total runoff at downstream stations. Average annual runoff of the Payette River near its mouth is about 2.2 million acre-feet of water per year, based on a 69-year record from 1928 to 1997. Table 9 lists average annual runoff and maximum and minimum recorded flows at principal gaging stations in the basin. Map 6 shows U.S. Geological Survey stream gage locations.

The Gold Fork River, Lake Fork, Deadwood River, Middle Fork Payette River, and Squaw Creek watersheds are the largest tributary drainages in the Payette River Basin, contributing significant water volume to total basin runoff. Annual estimates for major tributaries in each geographic section of the basin are listed in Table 10 (page 33).

The natural flow regime of the Payette River and its upper basin tributaries exhibit a seasonal pattern of low flows during the fall and winter months while snow is accumulating, and high flows during the spring and early summer snow melt season. Water content of the snow pack at the basin's higher elevations generally reaches a maximum in late April or early May, with snow pack persisting into June in most years. The annual high-water period begins with a gradual increase in discharge in March, peaks usually between April 15 and June 15, and recedes to base flows during August. Average runoff from April through July at Horseshoe Bend is 1.6 million acre-feet, or nearly 68 percent of the basin's annual average runoff. Low flows normally prevail from August through February. The Lowman hydrograph

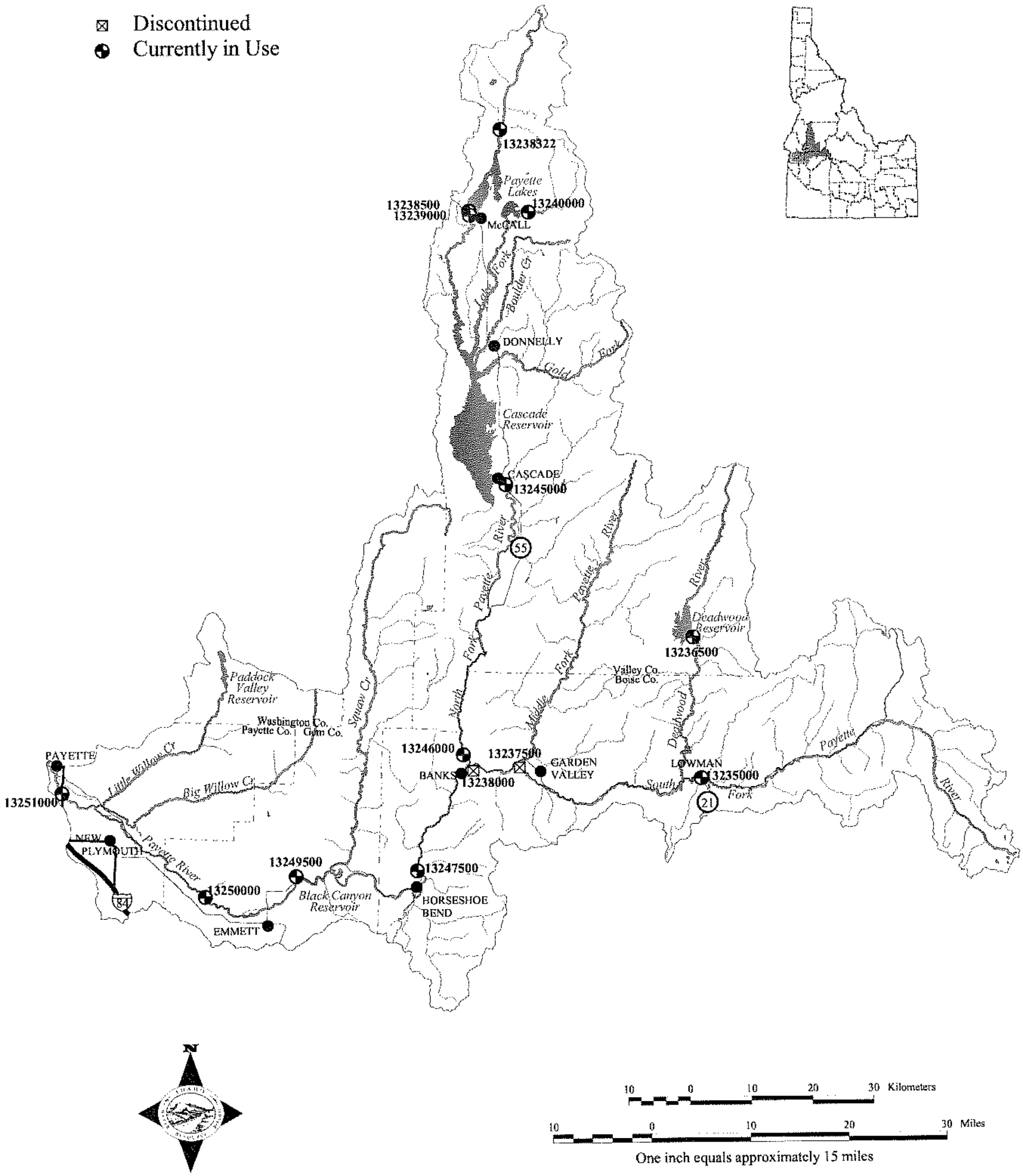
Table 9. Average Annual Runoff, Maximum and Minimum Recorded Flows at Principal U.S. Geological Survey Stream Flow Gaging Stations in the Payette River Basin.

Station	Period of Record	Drainage Area (square miles)	Ave. Annual Runoff Volume (acre-ft/year)	Max. cfs* (period of record)	Min. cfs* (period of record)
North Fork Payette Subbasin					
#13238322 North Fork Payette below Fisher Creek	1995 - 1997	85	278,500	4,570	4
#13239000 North Fork Payette at McCall	1919 - 1997	144	262,700	4,950	0
#13245000 North Fork Payette at Cascade	1941 - 1997	600	733,800	7,320	2
#13246000 North Fork Payette near Banks	1947 - 1997	933	963,000	8,830	36
South Fork Payette Subbasin					
#13235000 South Fork Payette at Lowman, Idaho	1941 - 1997	456	630,300	8,980	130
#13237500 South Fork Payette near Garden Valley	1921 - 1960	779	1,112,930	10,600	75
#13238000 South Fork Payette near Banks	1921 - 1960	1,200	1,513,100	13,800	225
Main Payette Subbasin					
#13247500 Payette River near Horseshoe Bend	1906 - 1916 & 1919 - 1997	2,230	2,347,000	27,000	260
#13249500 Payette River near Emmett	1925 - 1997	2,680	2,152,000	32,700	0.7
#13250000 Payette River near Letha	1952 - 1954; 1979-1986; 1994 - 1997	2,760	2,555,000	27,000	51
#13251000 Payette River near Payette	1928 - 1997	3,240	2,208,000	32,000	71

* cfs = cubic feet per second

Source: U.S. Geological Survey, 1996 and 1997.

Map 6. U.S. Geological Survey Stream Gaging Stations



y:\payette\arcview\projects\projects2\struct.apr (8/16/98)

Table 10. Estimated Average Runoff for Major Tributaries from Intermittent Measurements and Drainage Area Calculations.

Station	Est. Avg. Runoff (acre-ft/year)	Drainage Area (acres)
North Fork Payette Subbasin		
Gold Fork	150,000	97,600
Boulder Creek	40,000	32,300
Lake Fork Creek	100,000	53,400
South Fork Payette Subbasin		
Warm Springs Creek	60,000	35,575
Deadwood River	300,000	150,770
Middle Fork	226,000	217,700
Main Payette Subbasin		
Shafer Creek	54,000	55,990
Squaw Creek	110,000	218,900
Big Willow	18,000	102,200
Little Willow	14,000	98,000

Source: Peebles, 1962; Warnick, et al., 1981b; Sear-Brown Group, 1990; Natural Resources Consulting Engineers, Inc., 1996; Ondrechen, 1997.

in Figure 16 (page 37) is an example of this natural flow regime. Construction of Cascade and Deadwood reservoirs and other storage facilities have altered the natural flow regime for many rivers and streams in the basin.

Elevation is a critical factor defining the flow regime of basin tributaries. Streams at higher elevations, such as Clear Creek near Lowman, sustain low flows from late summer through the winter, and with the exception of major winter flood events, usually peak with late spring and early summer snow melt (Figure 13). Flow on unregulated streams at lower elevations increases through the winter and generally peaks in mid to late spring. A relatively low elevation stream, Big Willow Creek, displays a general increase in flow from September through February, and a flashy response to episodic rain and snow melt events (Figure 13). Its low flow period is the months of July and August. Summer thunderstorms may produce brief and rapid flow increases in both lower and higher elevation tributaries.

Tributary flows in the Payette River Basin are largely unregulated, although some tributaries do have storage reservoirs. Water storage and diversion have altered the natural flow regime of 55 tributary streams in the Payette River Basin. In general, water storage operations reduce spring peak flows and may reduce winter flows, depending on elevation of the project. At higher elevation sites, winter flows are naturally very low, and reservoir storage has little impact on the natural flow regime. At lower elevation sites, natural winter flows normally increase over the course of the season. Water storage may substantially reduce winter flow on these tributaries. Diversions may significantly diminish late spring and summer flows on basin tributaries. However, on tributaries with water storage projects, water releases during the irrigation season supplement naturally diminished summer flows

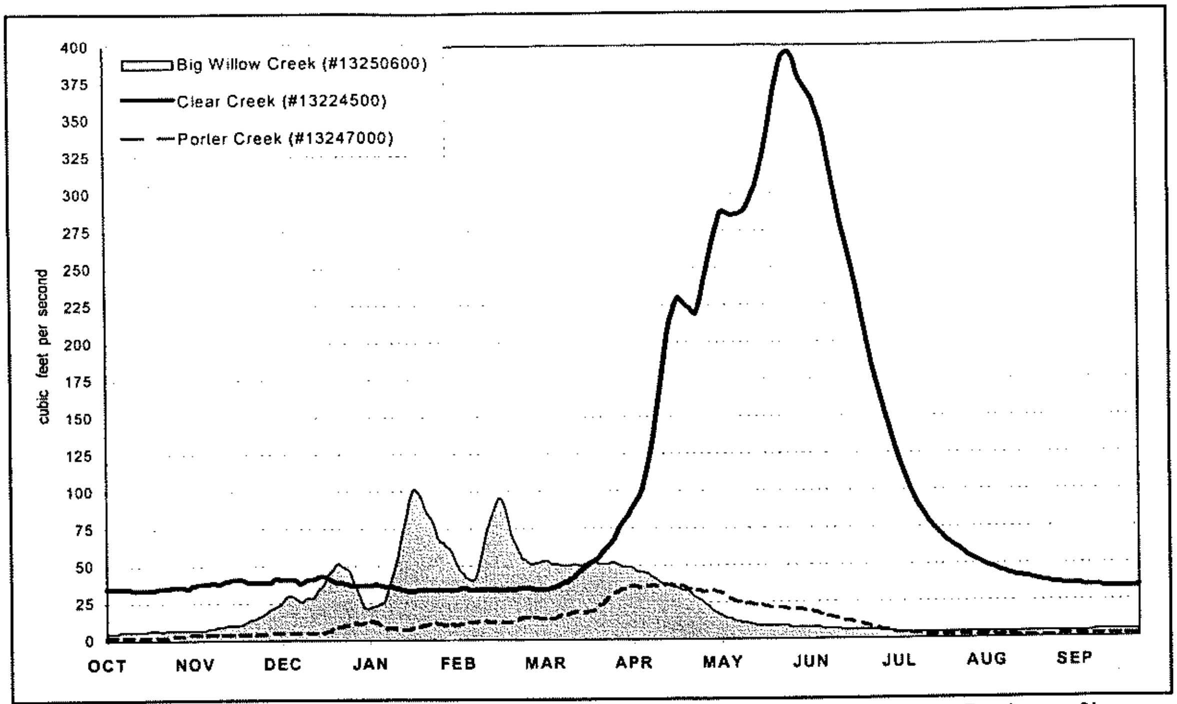


Figure 13. Comparison of Average Daily Flow of Lower Elevation Tributaries (Big Willow Creek near New Plymouth and Porter Creek near Horseshoe Bend) with a Higher Elevation Tributary (Clear Creek near Lowman). Note: Big Willow Creek gage period of record from 1961 to 1982; Porter Creek gage period of record from 1939 to 1945; and Clear Creek gage period of record from 1941 to 1949.

above diversions, and irrigation return flows may supplement discharges in the lower reaches.

__North Fork Payette Subbasin__

Figure 14 displays hydrographs for the North Fork Payette at McCall, Cascade, and Banks. The Cascade and Banks hydrographs reflect storage and release at Cascade Dam for flood control and irrigation. Payette Lake is regulated to store irrigation water, with storage releases typically occurring in September and October. At McCall the North Fork Payette flow displays a typical unregulated stream flow pattern despite operation of Payette Lake for storage. Payette Lake naturally stored water before construction of the dam, and the additional storage volume created by dam construction is relatively small. Therefore, regulation has not changed outflows below the lake significantly from what they were historically.

Through the winter the North Fork Payette at Cascade and downstream near Banks reflects natural precipitation and runoff, in addition to a winter minimum flow release of 200 cubic feet per second from Cascade Reservoir. Flow is fairly stable until March. From March through May, the Cascade hydrograph is relatively flat while Cascade Reservoir stores North Fork Payette flow for irrigation and flood control. When the reservoir is close to full, releases are increased to match inflow.

The increase in Cascade releases generally coincides with the McCall hydrograph apex (Figure 14). Flows at Cascade begin to drop mid-June, trailing the McCall hydrograph by approximately one month. By mid-July irrigation releases from Cascade Reservoir elevate downstream flow. Storage releases from Cascade Reservoir comprise more than 80 percent of the total North Fork Payette flow measured at Banks from July through September.

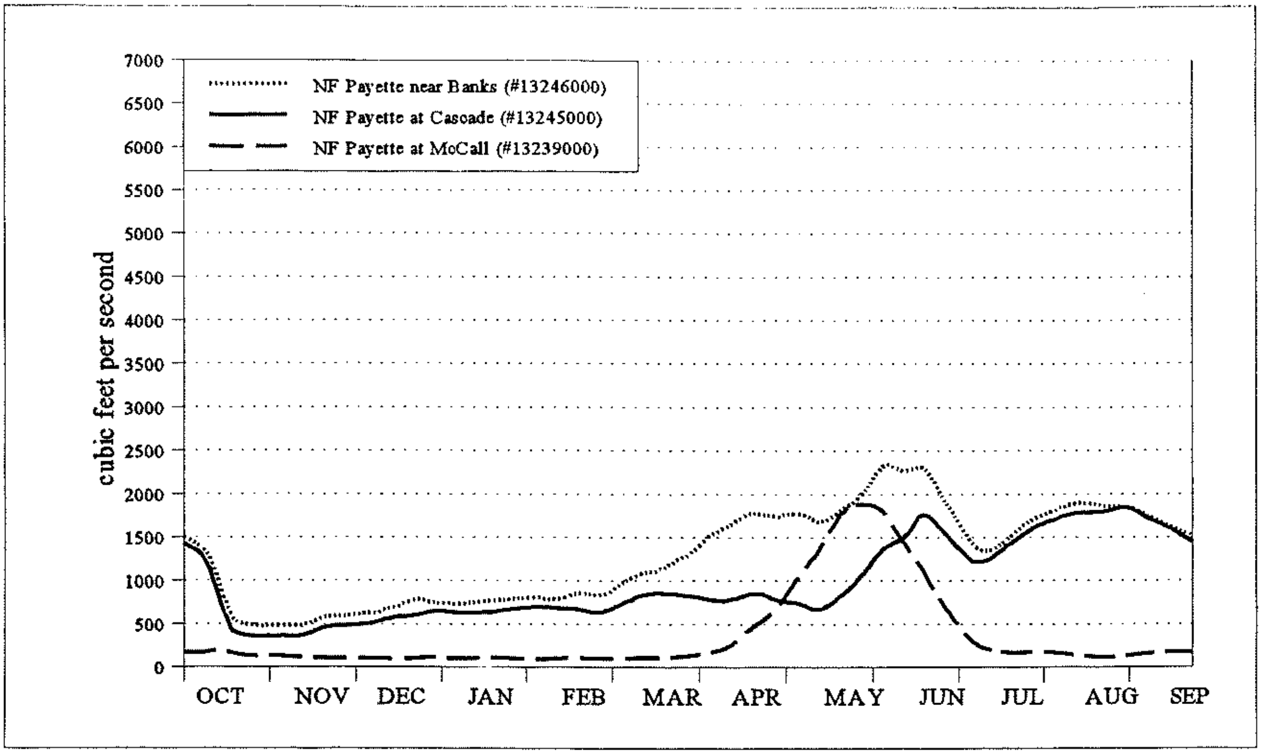


Figure 14. North Fork Payette Average Daily Flows for Period of Gage Record (see Table 9).

The North Fork Payette flow at Banks mirrors Cascade flow except during the early spring snow melt period (March-June), when tributaries below Cascade contribute significant runoff to the North Fork Payette. Tributary input between Cascade and Banks comprises more than 50 percent of the total flow measured at Banks during April and May storing. However by mid-summer, tributary input nearly ceases, and flow measured at Banks reflects Cascade Reservoir releases.

Figure 15 compares historic North Fork Payette flow measurements at Van Wyck with flow measurements at Cascade. The Van Wyck site, now covered by Cascade Reservoir, was located two miles upstream from the present gage location at Cascade. Although the Van Wyck record is short, it displays the classic natural flow regime, peaking during spring snow melt and low flow the remainder of the year.

Southwest Idaho's largest natural lake is Payette Lake, a 5,000-acre lake formed by glacial scouring approximately 15,000 years ago. Estimated volume of the lake is about 500,000 acre-feet. Mean lake depth is 121 feet, with a maximum depth of 304 feet (Woods, 1997a). Daily inflows at the lake are not measured, but annual outflows of 266,600 acre-feet are estimated using the U. S. Geological Survey gaging station downstream of the outlet dam on the North Fork Payette River. The contribution of groundwater to the lake water budget is unknown. Numerous small creeks flow into Payette Lake, but the single largest inflow is the North Fork Payette River.

Little Payette Lake, also formed by glaciation, lies slightly southeast of Payette Lake. The lake is fed and drained by the Lake Fork. Little Payette Lake is separated from Payette Lake by a narrow ridge and is 115 feet higher in elevation. The natural lake volume is an estimated 18,000 acre-feet, with a maximum depth of 105 feet (Anderson, 1997). Both Payette Lake and Little Payette Lake are regulated by dams at their outlets to provide storage

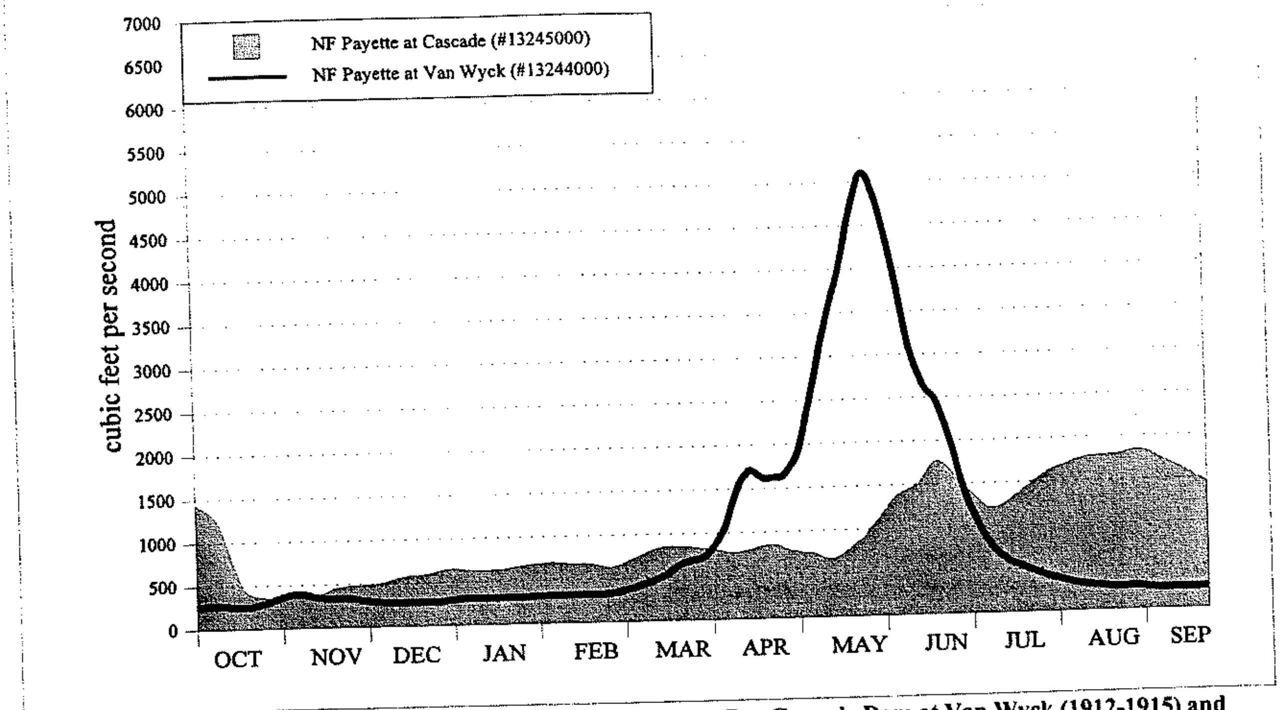


Figure 15. Comparison of North Fork Payette Average Daily Flow Pre-Cascade Dam at Van Wyck (1912-1915) and Post-Cascade Dam at Cascade (1948-1995).

water, with Payette Lake containing about 41,000 acre-feet of storage water and Little Payette Lake about 17,000 acre-feet.

South Fork Payette Subbasin

A comparison of the South Fork Payette hydrographs at Lowman, Garden Valley, and Banks shows fundamentally the natural flow pattern of an unregulated river (Figure 16). The South Fork Payette gage near Garden Valley was located upstream of the Middle Fork confluence, and the South Fork Payette River gage at Banks measured flows just above the confluence of the North Fork Payette and South Fork Payette. Deadwood River inflows are reflected in the Garden Valley hydrograph. The flow of the South Fork Payette at Lowman, 33 river miles upstream of the Banks gage, represents a substantial 45 percent of that observed at Banks through the winter and spring snow melt period. By late summer, average Deadwood Reservoir releases comprise nearly 70 percent of the downstream South Fork Payette flow.

Deadwood River flows are regulated by Deadwood Dam, 18 miles upstream from its mouth. Water is stored in Deadwood Reservoir for irrigation in the lower Payette Valley and for power generation at Black Canyon Dam. Figure 17 compares Deadwood River flow before Deadwood Dam construction with regulated flow after its construction. Winter flows are fairly similar. Storage during the winter months decreases natural winter flow by an average 40 cubic feet per second. Reservoir operation considerably reduces spring peak flows and substantially increases late summer flows. Natural high flows during the spring snow melt period are reduced by an average of 300 cubic feet per second. Water releases through the months of July, August, and September average 600 cubic feet per second compared with an average 150 cubic feet per second prior to project operation.

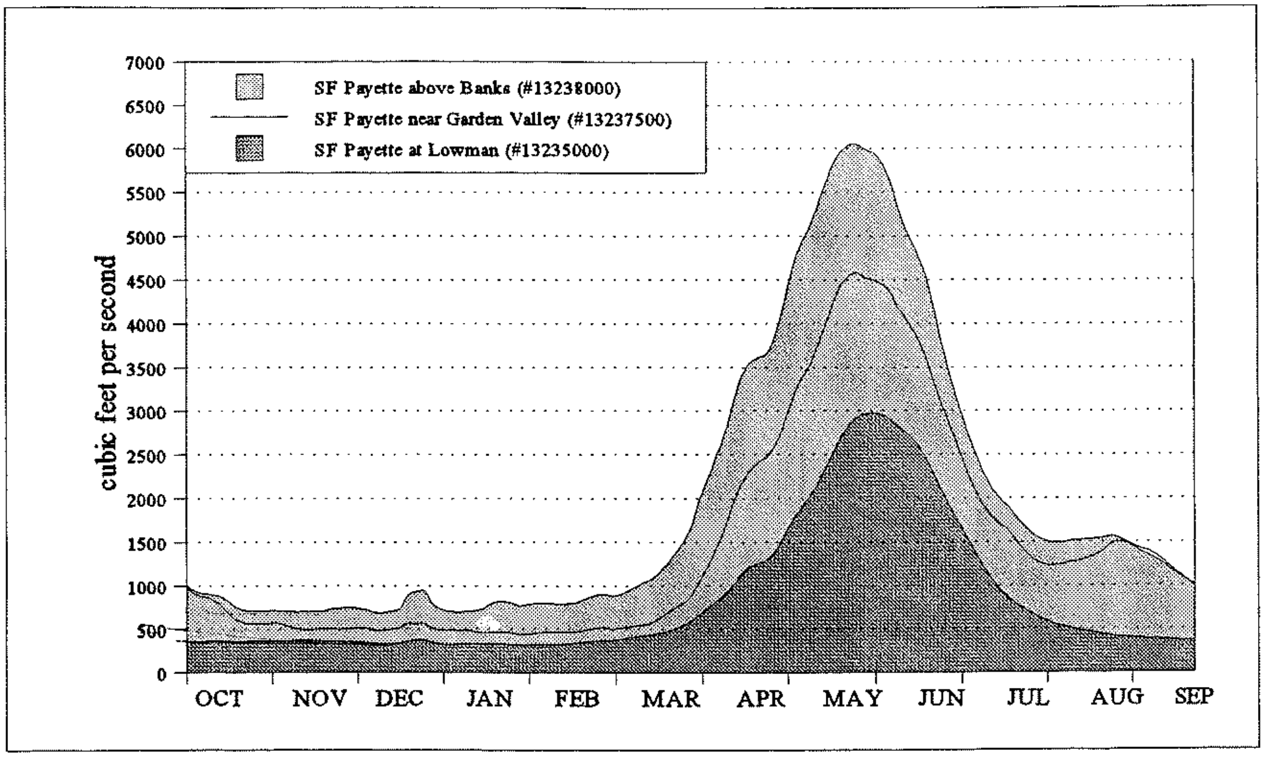


Figure 16. South Fork Payette and Payette River Average Daily Flows for Period of Gage Record (see Table 6).

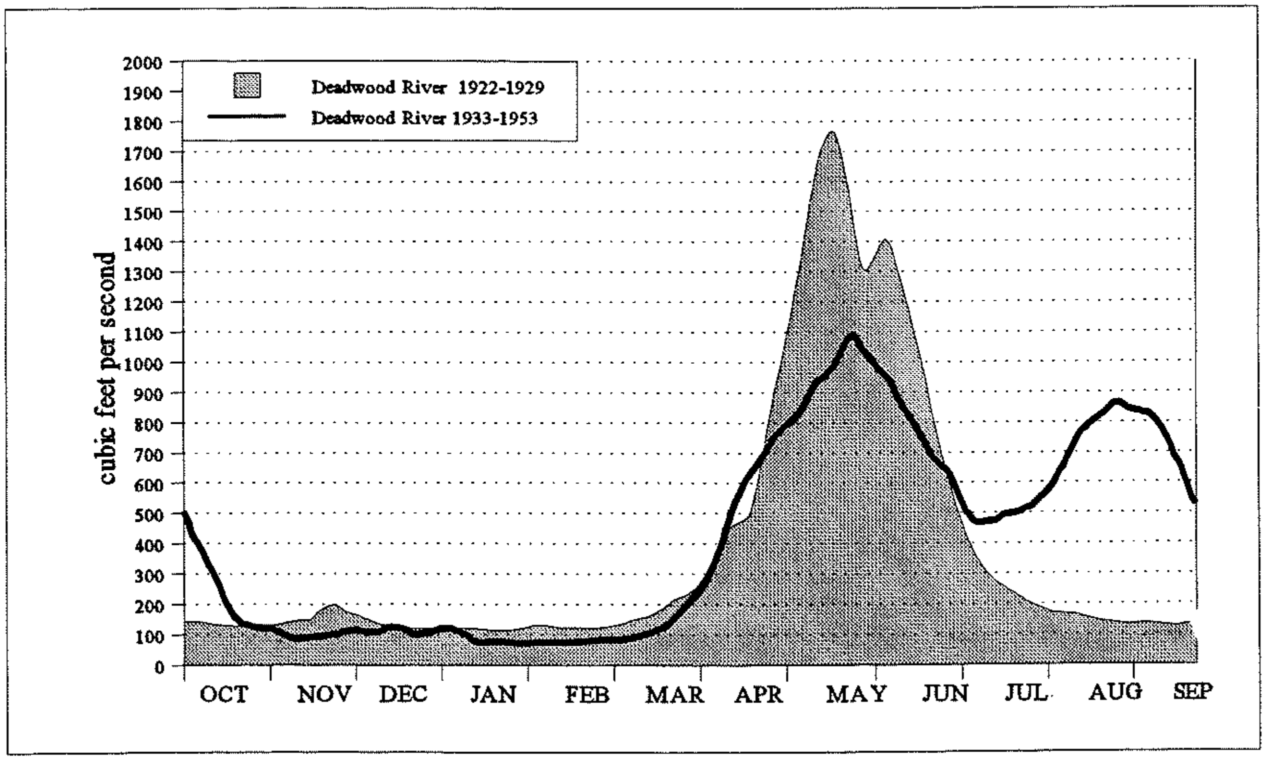


Figure 17. Comparison of the Average Daily Flow of the Deadwood River Near the Mouth – Pre-dam (1922-1929) and Post-dam (1933-1953) (U.S. Geological Survey gage # 13237000).

The Middle Fork Payette inflow substantially increases South Fork Payette flow through the winter and spring. It contributes an average 300 cubic feet per second, or approximately 35 percent of measured South Fork Payette flow near Banks during the winter, and an average 30 percent during the spring snow melt period. However by late August, Middle Fork input is negligible, and the South Fork Payette flow near Banks reflects the flow measured at Garden Valley.

Main Payette Subbasin

Several distinctive traits of the Payette River's seasonal flow pattern in the lower basin are shown in Figure 18. Evident in each of the hydrographs is a gradual flow increase through the winter months attributable to lower elevation tributaries. The Horseshoe Bend hydrograph follows a fairly unregulated pattern, but late summer releases from Cascade and Deadwood reservoirs are readily apparent. Payette River flows from July through September, measured at Horseshoe Bend, are significantly higher than natural flow levels for that time of year.

From October to April, Payette River flow at Letha and near Payette is greater than flow measured at Horseshoe Bend. Relatively low elevation tributaries between Horseshoe Bend and Payette contribute significant flows through the late winter and early spring. By mid-April Payette River flow at Letha and Payette is less than flow at Horseshoe Bend due to diversions for consumptive uses. Payette River flow at the Letha gage averages 1,000 cubic feet per second during the growing season. At times, irrigation diversions between Horseshoe Bend and Letha may reduce Payette River flow at the Letha gage to 135 cubic feet per second.

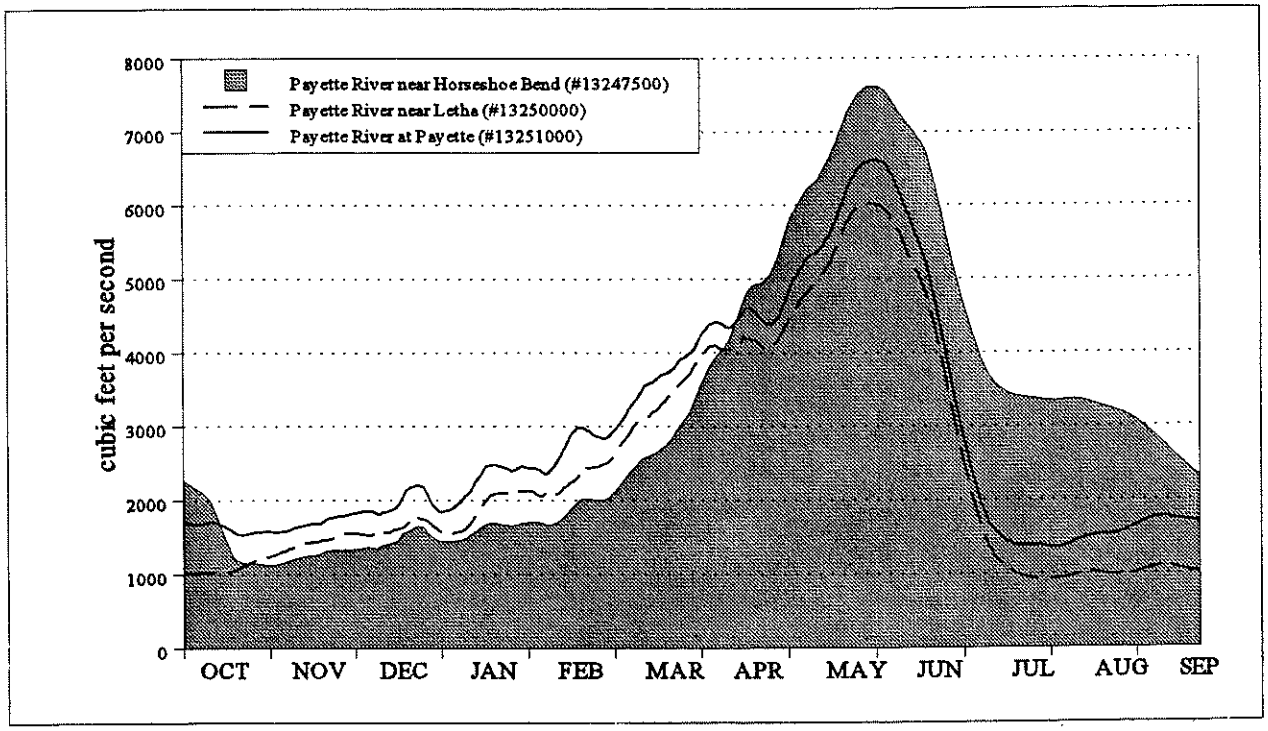


Figure 18. Payette River Average Daily Flows for Period of Gage Record (See Table 9). (Note: Letha average flows were estimated to correct inherent discrepancies in comparing a short record period at Letha with a much longer period of record at Payette. Letha average flows were calculated by averaging the difference between flows at Payette and flows at Letha for each day of common record.)

Payette River flow near Payette is slightly higher than the measured flow at Letha due to tributary inflows and irrigation return flows. Big and Little Willow creeks contribute significant flows to the river below Letha through the winter and early spring. By late-June contributions from these tributaries have generally ceased and flows past Letha approach the flow at Payette. Irrigation return flows between the two gages increase river flow, measured at Payette, by mid-July. Irrigation return flows and ground water intercepted by drainage channels below Letha account for 30 percent of river flow at Payette from about mid-July to mid-October.

Hydrography in the lower Payette Valley is complex due to numerous irrigation canals, laterals, and drainage channels. Irrigation wasteways return flow on both sides of the Payette River. These drainages also carry ground water and runoff from precipitation and snow melt. Although many of these drains have been measured, no clear separation of surface return from ground-water flow has been made. Ingham (1996) estimated a 200,000 acre-feet discharge to the Payette River between Emmett and Payette by subtracting flow of the Payette River near Emmett and inflow from Big and Little Willow Creeks from flows in the river near Payette. Nearly all of the drainages carry water year-round, but flows are generally greatest during the irrigation season. The Payette Soil and Water Conservation District (1993) measured irrigation wasteways and drains along the lower 15 miles of the river during the 1991 irrigation season. Average drain discharge was 20 cubic feet per second, and ranged from 60 cubic feet per second to 1.2 cubic feet per second.

Flood Occurrence

Flood-stage flows over-top stream banks and levees, and extensively erode channels and floodplains. Flood-stage flows in the basin's rivers and streams may develop from frontal system or convective thunderstorm rainfall, excessive rainfall associated with snow melt, rapid spring snowmelt, or runoff from an excessive snowpack. Closely associated with flood events in the Payette River Basin are mud and debris flows triggered by excessive runoff over saturated soils.

Flooding problems on the North Fork Payette River are predominately associated with overflow near McCall downstream from Payette Lake Outlet and at Cascade (Federal Emergency Management Agency, 1990). The maximum discharge of the North Fork Payette at McCall was 4,950 cubic feet per second in June 1974 (U.S. Geological Survey, 1996). This equates to an exceedence probability of less than one percent.

Flooding in the South Fork Payette Subbasin is mostly due to rain-on-snow events, very warm temperature snowmelts, or short duration-high intensity summer storms (Federal Emergency Management Agency, 1988). Rapid snowmelt has caused major flooding on the South Fork Payette near Lowman, while rain-on-snow events are predominate causes of flooding on the Middle Fork Payette.

The largest flood in Boise County occurred in December 1964 when the South Fork Payette near Banks had a flow of 20,800 cubic feet per second, with an estimated 7,350 cubic feet per second contributed by the Middle Fork Payette (Federal Emergency Management Agency, 1988). Upstream the peak discharge for the South Fork Payette near Lowman was 5,280 cubic feet per second. These flows were deemed a four year-recurrence interval for the South Fork Payette at Lowman, but a 200-year event for the Middle Fork Payette and the South Fork Payette near Banks. Peak flows at the South Fork Payette Lowman gage have occurred in May or June, indicating high elevation snowmelt events. The record peak flow was 8,980 cubic feet per second in June 1974. By comparison, flows during the January 1997 flood event were 4,260 cubic feet per second (Ondrechen, 1997).

The flatness of the lower Payette Valley floor allows extensive flooding with only 2 to 5 feet of overbank depths (U.S. Army Corps of Engineers, 1982). The flood patterns in the Emmett Valley are complicated by the numerous irrigation canals and sloughs (Federal Insurance Administration, 1977; U.S. Army Corps of Engineers, 1982). Floods usually occur from heavy rainfall augmented by snowmelt during winter or early spring.

At Horseshoe Bend the Payette River channel can accommodate flows exceeding 18,000 cubic feet per second (Wells, 1997). Flows at or exceeding 16,000 cubic feet per second are considered flood-stage flows below Emmett (Federal Insurance Administration, 1977; Mellema, 1997). Payette River flows in excess of 16,000 cubic feet per second at Emmett have occurred on eight occasions in the last forty years. Probabilities of flood events under existing, regulated conditions are shown in Table 11 for major rivers in the Payette River Basin.

Table 12 and Figure 19 show that Payette River flood-stage flows are principally related to spring snow melt, which generally produces sustained high river flows. Flood-stage flows may persist for several days to several weeks, while flood flows caused by other circumstances generally last for a much shorter period of time. The highest flood-stage flows were produced by excessive rainfall in association with a warm, regional frontal system that also rapidly melted snow at low and intermediate altitudes. The maximum instantaneous flow of record at several Payette River stations occurred in December 1964 under these conditions: the Payette River flow was 27,000 cubic feet per second at Horseshoe Bend and 32,700 cubic feet per second at Emmett.

Large-scale flooding inundated the Payette River Basin in early January 1997, virtually repeating the 1964 flood scenario, with flows of 24,400 cubic feet per second at Horseshoe Bend and 32,300 cubic feet per second at Emmett (Brennon, 1997; Figure 20, page 42). There was widespread water-related damage and extensive landslide activity (Figure 21, page 42). Analogous to the 1964 flood, the primary factors contributing to the 1997 flood-stage flows were repeated above-normal precipitation events in late fall and early winter which produced saturated soils and above-normal snowpack and snowpack water content; and major storms in late December and early January which brought substantial moisture and unseasonably mild air from the subtropics into

Table 11. Flood Exceedence Probabilities for Major River Reaches in the Payette River Basin.

Recurrence Intervals (years)	**2**	**5**	**10**	**25**	**50**	**100**
Exceedence Probability (percent)	**50%**	**20%**	**10%**	**4%**	**2%**	**1%**
North Fork Payette						
at McCall	4,820	2,950	3,600	3,950	4,300	4,590
at Banks	4,130	5,770	6,850	8,200	9,200	10,200
South Fork Payette						
at Lowman	4,320	5,640	6,420	7,320	7,940	8,530
at Banks	7,920	10,900	12,700	15,000	16,600	18,100
Main Payette						
at Horseshoe Bend	12,700	17,400	20,200	23,400	25,600	27,600
at Emmett	13,300	18,700	22,00	26,100	29,000	31,700

Source: U.S. Geological Survey, 1996.

Table 12. Major Floods in the Payette River Basin, 1927-1997.

Year	Month	Flow at Horseshoe Bend	Flow at Emmett
1927	May	19,000 cfs	21,400 cfs
1928	May	21,500 cfs	22,000 cfs
1933	June	18,900 cfs	20,700 cfs
1936	April	18,900 cfs	21,600 cfs
1938	May	20,100 cfs	22,800 cfs
1940	March	13,500 cfs	19,200 cfs
1943	June	20,000 cfs	21,900 cfs
1946	April	15,600 cfs	18,600 cfs
1947	May	16,900 cfs	17,900 cfs
1948	June	15,300 cfs	16,700 cfs
1952	April	16,600 cfs	18,400 cfs
1955	Dec	19,200 cfs	22,700 cfs
1957	May	14,000 cfs	18,200 cfs
1964	Dec	27,000 cfs	32,700 cfs
1971	June	20,400 cfs	21,300 cfs
1974	June	19,300 cfs	18,600 cfs
1978	June	11,600 cfs	17,200 cfs
1983	May	18,000 cfs	19,700 cfs
1984	May	14,400 cfs	16,900 cfs
1986	March	12,200 cfs	16,400 cfs
1997	January	24,400 cfs	32,300 cfs

Source: U.S. Geological Survey, 1991; Brennon, 1997; and Ondrechen, 1997.

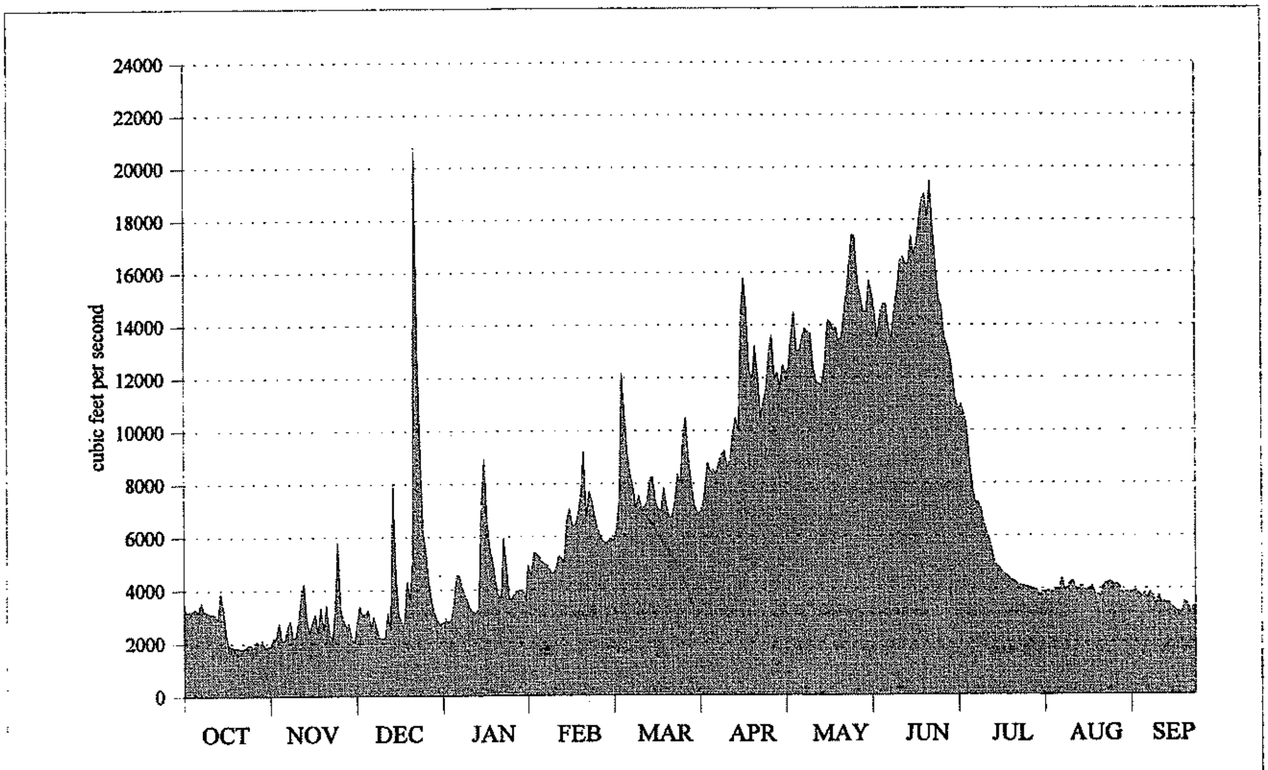


Figure 19. Maximum Mean Daily Flows at Horseshoe Bend -- 1958 to 1995.

Figure 20. Flooding Along the Payette River near Payette, Idaho, January 1997.

Figure 21. Landslide Debris Along the South Fork Payette, January 1997.

southwest Idaho. Garden Valley received a 100+ year precipitation event, with eleven inches between December 24, 1996 and January 2, 1997, while Lowman registered over eight inches, and Cascade and Ola six inches (National Weather Service, 1997). In addition to the exceptionally heavy rainfall, warm temperatures melted mid-elevation and low-elevation snowpack, resulting in massive run-off, debris flows from supersaturated soils, and eventual flooding of many of the basin's rivers and creeks.

Mass Wasting (Slope Failure)

In the Payette River Basin mass wasting, or slope failure, often occurs in concert with flood flows. The terms "debris flow," "debris flood," "debris torrent," "mudslide," "mudflow," and "landslide" have different technical definitions, but they all refer to similar processes by which mixtures of water, soil, and rock debris may rapidly and destructively flow down streambeds or slopes. Water usually plays an important role in landslide and debris flow development; it is often the critical factor that triggers the downslope movement.

Intense rainstorms, rain-on-snow events, or rapid snowmelt, especially when the soils are already thoroughly wetted, may make the soil mass unstable and susceptible to mass movement. The introduction of large quantities of water onto slopes can trigger landslides in two primary ways: (1) the water can infiltrate into the slope, reducing the strength of the slope material; and/or (2) the water can concentrate on the surface as runoff to initiate a debris flow, which gains sediment as it moves down the slope.

Natural factors contributing to mass wasting include slope morphology, slope material, bedrock geology, vegetation, and climate. Generally in a given material, the steeper a slope is, the more prone it is to sliding. In the Idaho batholith, Megahan and others (1979) found that most slides occurred on slopes of about 30 degrees. Jenks (1997) found that slopes of 60 percent or greater were much more susceptible to mass failures in the headwaters of the North Fork Payette River watershed.

Landslides associated with the January 1997 flooding were distinctly delineated in an elevation zone between 4000 and 5000 feet (Gillerman, 1997a). Intense landsliding was generally confined to the South Fork Payette, Middle Fork Payette, and main Payette River watersheds above Gardena on steep slopes where the ground was not frozen or snow-covered. South-facing slopes, less prone to being frozen, were hit hardest, as were areas that had sparse tree cover or those which had recently burned (Gillerman, 1997a).

Drought Occurrence

Drought in southwest Idaho is fairly common. Droughts decrease stream flow, the availability of water for storage in reservoirs, and ground water storage. Droughts during the past several decades generally were the result of an unseasonable northward displacement of the Pacific high-pressure system, or the positioning of a polar front at much lower latitudes than usual.

Significant droughts, indicated by the Surface Water Supply Index (SWSI), are illustrated in Figure 22 and summarized in Table 13. The Surface Water Supply Index was developed by the U.S. Natural Resources Conservation Service to quantify water availability in a basin compared to historic supply. It is calculated by summing the two major components of water supply, March 31 reservoir storage and April through September stream flow, and fitting a scaled probability distribution. Values range from +4.1 (extremely wet) to -4.1 (extremely dry). A value of zero indicates a median water supply compared to historic occurrences. Figure 22 reveals that drought existed more than one-third of the period between 1920 and 1996.

Figure 23 illustrates the general sequence of wet and dry periods at the Horseshoe Bend gaging station. Conditions in the Payette River drainage for the period 1987 through 1992 were drier than any other six-year sequence in the basin's hydrologic record. Scant winter snowpacks and prolonged periods of greater than average temperatures resulted in unseasonable early snow melt, high water demands, and the lowest stream flows since 1977.

In southwestern and central Idaho, this six-year drought was more severe than the 1930s drought. Payette River runoff at Horseshoe Bend averaged only 62 percent of normal runoff from 1987 to 1992. Low-flow records were set for many days during the summers of 1987, 1988, 1991, and 1992 at long-term gages on the Payette River system. Cascade Reservoir contents on June 30, 1992 were 551,000 acre-feet of water, lower than any historic or simulated volume for any June 30th in the record.

The most prolonged historical drought was the decade of the 1930s; that drought spanned 10 years. Payette River runoff at Horseshoe Bend averaged only 74 percent of normal runoff between 1929 and 1937, and 80 percent of normal runoff from 1929 through 1941.

GROUND WATER

Map 7 portrays general lithology in the Payette River Basin. Most rock units in the basin contain some ground water. However, about 90 percent of the ground water utilized in the Payette River Basin comes from alluvium, chiefly

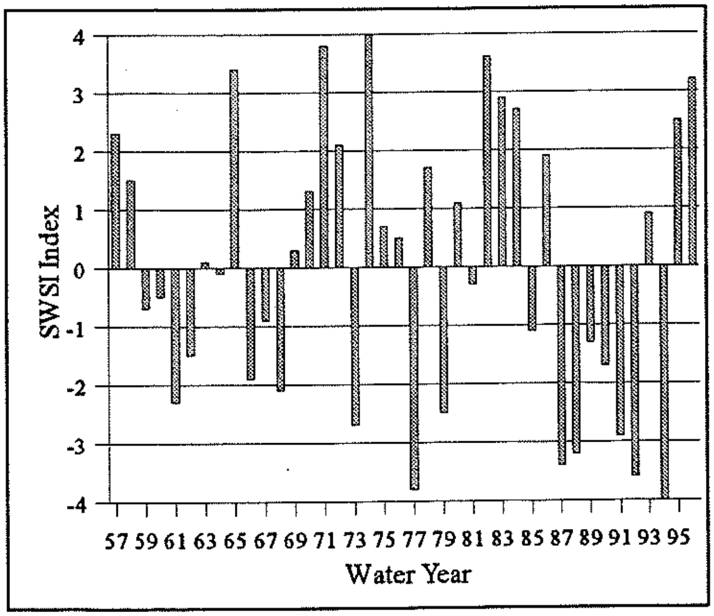


Figure 22. Payette River Basin Surface Water Supply Index for Water Years 1957 - 1996 (U.S. Natural Resources Conservation Service, 1994)

Table 13. Major Droughts in Southwest Idaho, 1894-1996.

Years	Area Affected	Recurrence Interval (Years)
1929 - 41	Statewide	>50
1959 - 63	Southern and Central Idaho	10 to >25
1966 - 68	Southwest Idaho	10 to >25
1977	Statewide	10 to >25
1987 - 94	Statewide	25 to >50

Source: U.S. Geological Survey, 1991; Sutter, 1996.

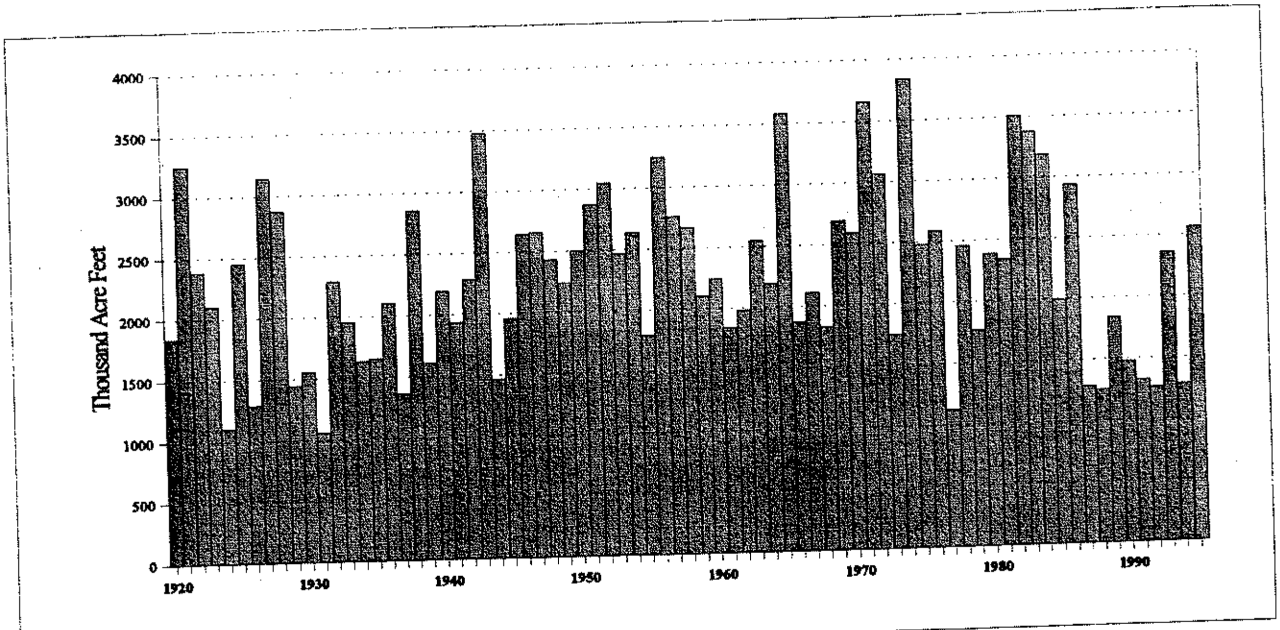
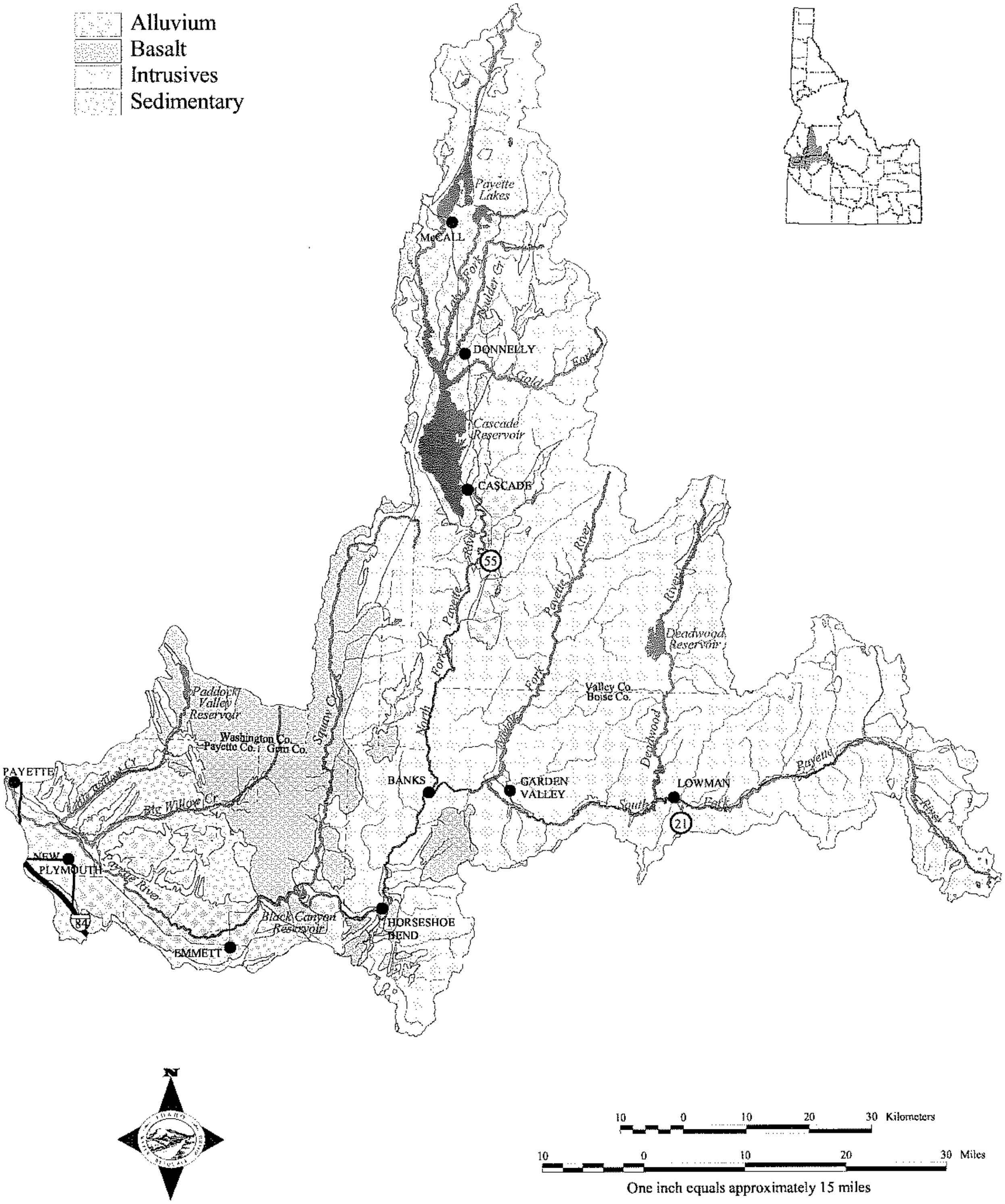


Figure 23. Annual Runoff of the Payette River at Horseshoe Bend, 1920-1995.

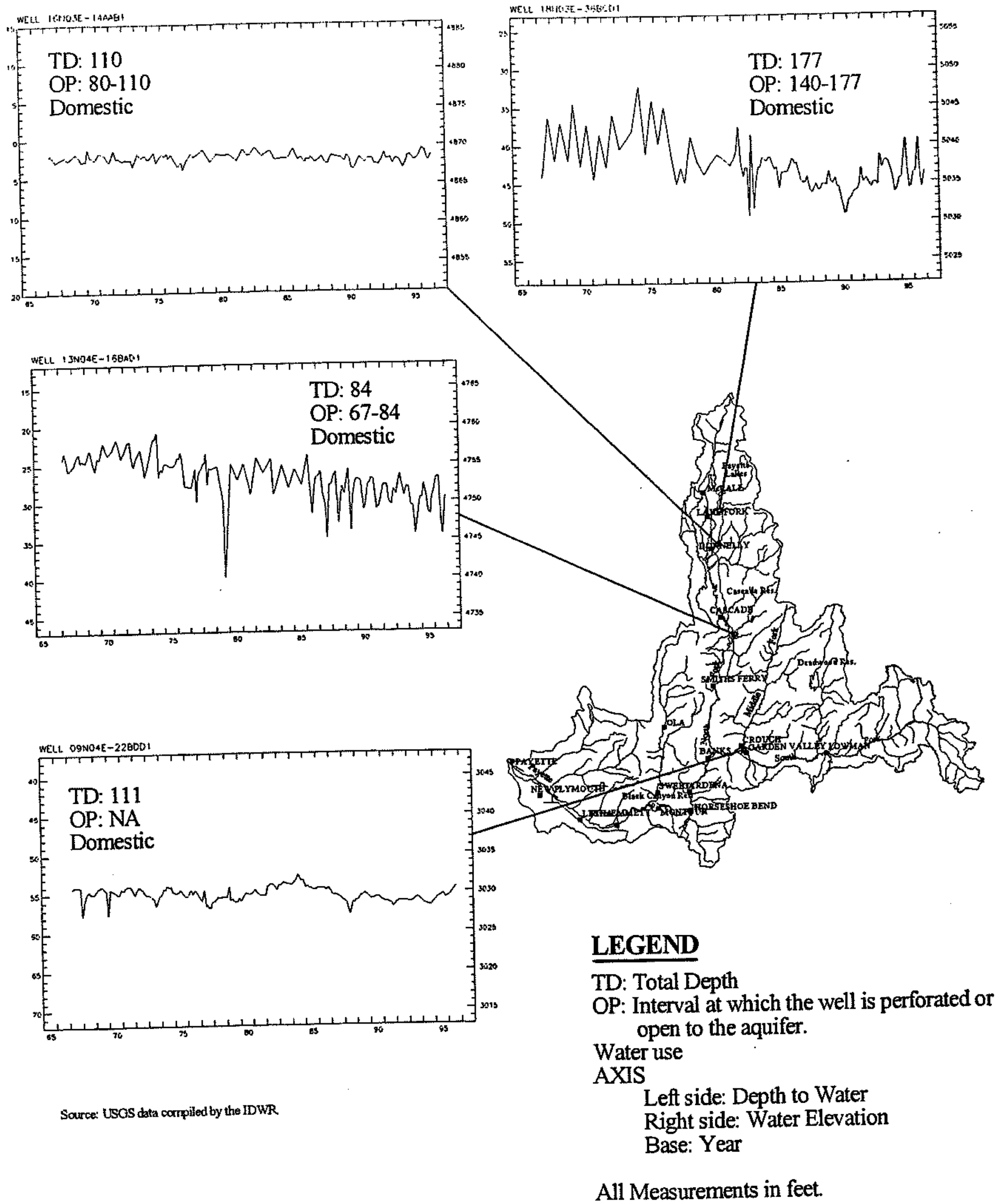
unconsolidated sand and gravel deposits in valley-fill. Long-term water level trends in the basin's valleys appear generally stable (Figures 24, page 46 and Figure 25, page 47). Incidental ground water recharge in the valleys is provided by irrigation surface water diversions, stream losses, lateral ground water inflow, and precipitation. Ground water is discharged into field drains, springs, and streams.

In the mountainous upper basin, ground water supplies are meager to modest. In general, porosity and permeability of the granitic and metamorphic rocks are low. However, where the rock has been weathered, it is considerably more porous and permeable than the underlying bedrock. In the upper basin, this weathered zone supports many small springs and shallow wells (Keller Associates, 1996). A well that encounters faults or rock joints may produce up to 50 gallons-per-minute, but five gallons-per-minute is a more typical yield (Slifka, 1997). In the basin's narrow canyon corridors, ground water supplies are confined chiefly

Map 7. Lithology

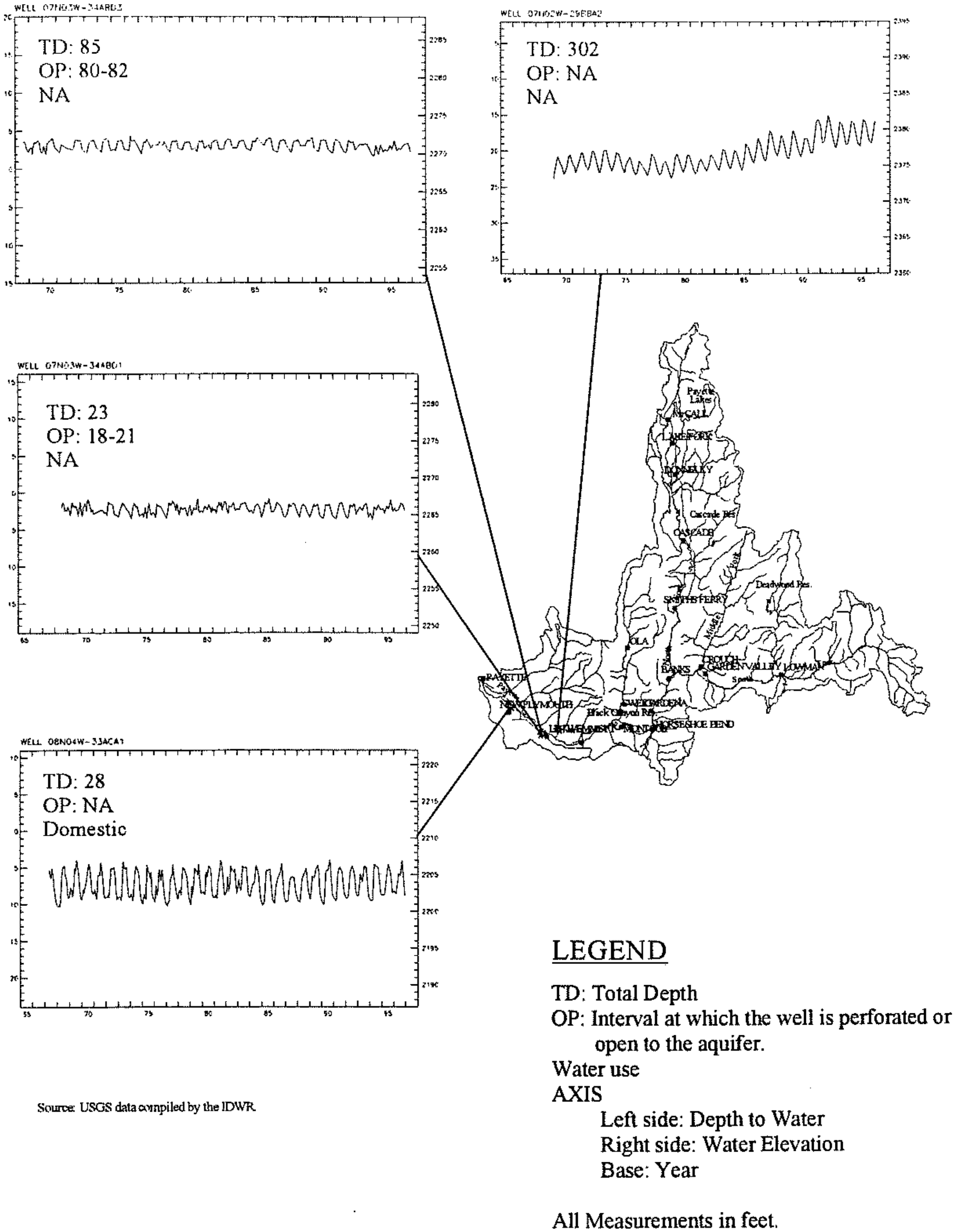


y:\payette\arcview\projects\projects2\land.apr (8/17/98)



Source: USGS data compiled by the IDWR.

Figure 24. Ground Water Levels for the Payette River Basin Above Banks.



Source: USGS data compiled by the IDWR.

Figure 25. Ground Water Levels for the Payette River Basin Below Banks.

to the river alluvium, and the water table in these areas fluctuates with the river stages.

Recharge in the mountains is almost entirely from precipitation and snowmelt. Soils derived from granitic or metamorphic parent materials have high infiltration rates, but limited storage capacities. Water stored in weathered granite moves only short distances as subsurface flow, and much of the subsurface flow is in the upper 20 feet of soil (Nelson, 1976). The geologic unit, however, provides short-term storage space for a large volume of water that maintains the base flow of mountain streams. Discharge from the weathered material also moves laterally into the alluvial deposits and younger volcanic rocks underlying the valleys.

In the lower basin, a succession of basaltic lava flows comprise the upper portions of the Big and Little Willow Creek drainages and most of the Squaw Creek drainage. Interbeds of tuff, ash, and sand and gravel are common (Savage, 1961). Individual basalt flows generally have low permeability, but jointing, fracturing, weathering, and openings caused by the expansion of gases when the lava cooled, provide space for water storage and avenues for movement (Kinnison, 1955). Contact zones of successive flows generally have high to moderate permeability. Where wells penetrate several contact zones, moderate water yields may be realized.

Recharge in the basalt upland and plateau areas is by direct precipitation, snowmelt, and seepage from streams. Generally only the major streams in the basalt uplands benefit from ground water discharge; the smaller streams are usually above the regional water table and consequently intermittent (Pacific Northwest River Basins Commission, 1970).

Sedimentary deposits in the Payette River Basin consist of thin sections of silt, tuffaceous siltstone, sandstone, clay, and fine sand, interbedded with thinner lenses of medium to coarse sand and gravel that are moderately permeable (Savage, 1961). The finer-sized sediments act as confining beds for the sand and gravel aquifers and may contribute to artesian pressure (Kinnison, 1955). The deposits are of Quaternary and Tertiary age, and include sediments of the Snake River and Idaho groups, the Payette Formation, and similar strata (Savage, 1961).

Sedimentary deposits are scattered throughout the basin. The deposits are prominent in the lower Payette Valley where they form terraces and bluffs along the Payette River. Some Payette Formation sediments are found in Garden Valley (Johnson, et al. , 1988). Wells drilled in sedimentary deposits a few hundred feet deep may furnish up to 20 gallons of water per minute (Slifka, 1997). In general, the younger, more coarse strata in the Snake River and Idaho groups yield more water than the finer strata of the Payette Formation and equivalents.

Major Ground Water Sources

Alluvium in the Payette River Basin comprises the present flood plain; river benches and terraces; glacial outwash and other deposits; lacustrine silt, clay, and fine sand; and windblown sand deposits. Loess, or windblown silt, is evident around Payette. Some alluvial deposits are interbedded with younger basaltic lavas. The amount of water present and available for use in alluvium is controlled by the size, sorting, shape, and roundness of the sediments, and the size and efficiency of the intake area (Kinnison, 1955).

Extensive deposits of porous and permeable coarse sand and gravel are found in Long Valley and lower Payette Valley alluvium. The deposits are thick enough to yield moderately large to large quantities of ground water. Yields from the coarser material are commonly 20 to 50 gallons-per-minute (Slifka, 1997). Garden Valley and the upper Deadwood Valley contain an unknown thickness of alluvial deposits with granitic and metamorphic rock boundaries.

Significant ground water resources exist in the deep valley fill of the Long Valley-Round Valley area. Important aspects of the geologic framework that control the natural ground water hydrology are the steep granitic mountains in fault contact with a very thick (depth to 7,000 feet) accumulation of sedimentary materials in the valley (Kinoshita, 1962).

The upper hundred feet of Long Valley fill is comprised of sandy glacial outwash material, river alluvium, and minor amounts of finer-grained sediments of former boggy areas now buried. These sandy surficial materials have relatively high vertical and lateral permeability. Natural water tables are typically 10 to 20 feet deep beneath much of the main valley floor, and only a few feet above the elevation of the perennial streams that have cut narrow flood plains 10 to 50 feet into the outwash surfaces (U. S. Forest Service, et al., 1990). Ground water deeper than 100 feet may be confined and vertically separated from the shallow ground water by clay and silt layers. Geophysical logs indicate that the vertical permeability of the deep aquifers is very low.

Ground water recharge in Long Valley-Round Valley is from downward percolation of precipitation and snowmelt, runoff from surrounding uplands, and leakage from Payette Lake, Cascade Reservoir, and the North Fork Payette River and its tributaries. Irrigation raises the water table as close as ten feet to the surface along ditches and laterals, or where fields are flood irrigated.

Ground water in the lower Payette Valley occurs in three main aquifer zones associated with the surficial alluvial valley-fill deposits, underlying unconsolidated sediments, and older sedimentary and volcanic rocks. The first and most productive is a shallow zone in sand and gravel lenses of surficial deposits and terrace gravels (Savage, 1961; Steed, et al. , 1993). A second zone is an intermediate, warmer unit in sand layers within the blue clay of the Glenns Ferry Formation sediments. The third zone is generally more than 1700 feet deep in the lower Glenns Ferry Formation (Kinnison, 1955; Deick and Ralston, 1986; Steed, et al., 1993).

Most ground water wells in the valley are less than 100 feet deep. In most cases, well depths increase as the land surface elevation increases. Farther away from the floodplain and nearer the terraces, ground water is typically greater than 100 feet below the surface (Deick and Ralston, 1986). Between Emmett and Payette, thick deposits of clay confine sand and gravel aquifers, and as a result, flowing wells are common in this region (Kinnison, 1955; Deick and Ralston, 1986; Steed, et al., 1993).

Ground water in the Payette Valley is recharged by infiltration from irrigation, rivers and streams, septic/sewage system effluents, and precipitation in mountain areas. Near the river, ground water recharge is usually associated with flooding of the river itself. An unknown volume of water leaves the basin as ground water discharge to the Snake River (Deick and Ralston, 1986). The deeper aquifers are recharged mainly from the shallow aquifers and from stream flow along the Boise Front (Steed, et al., 1993).

Evaluations of water level contours suggest that ground water flows toward the Payette River from the highlands. The Payette River receives discharge from the ground water system along most of its course in the lower valley. A ground water divide exists along the ridge which parallels Interstate 84 on the south (Deick and Ralston, 1986; Steed, et al., 1993). Ground water to the southeast of this divide flows toward, and an unknown volume is discharged to the Snake River (Deick and Ralston, 1986). Water north and east of the divide flows toward the Payette River. Seeps and springs at the foot of terraces that border the valley mark discharge from the shallow aquifers.

Ground water levels under natural conditions are generally highest in the spring and lowest in the fall. Late winter and spring are times of recharge from snowmelt, high streamflow, and increased rainfall. However, ground water levels in areas of intense surface water irrigation are lowest in the spring prior to the irrigation season, and highest in the fall at the end of the irrigation season. Ground water levels for wells in the valley indicate a direct relationship to intensive surface irrigation.

Springs

Map 8 shows spring locations identified through the Idaho Department of Water Resources water rights database and the Idaho Geological Survey (Mitchell, et al., 1986 and 1991). Springs are found throughout the Payette River Basin, but are conspicuously located along stream courses, canyons, or mountain bases where fractures and faulting allow ground water to discharge. Basin springs are most commonly found in fractured basalt, and fractured and weathered granitic rock.

Spring discharge rates in the Payette River Basin are small compared with spring discharge rates of 300 to 500 cubic feet per second from the Snake Plain Aquifer. Some of the larger discharge rates in the basin issue from drains in the lower Payette Valley. Ground water discharge to one drain is approximately 24 cubic feet per second.

Springs in the Payette River Basin are important water sources for domestic and livestock use. Basin springs are particularly significant water sources in mountainous areas, the Ola Valley, and the headwaters of Big and Little Willow creeks. Water appropriations from spring sources average 0.1 cubic feet per second in the Payette River Basin and total over 150 cubic feet per second.

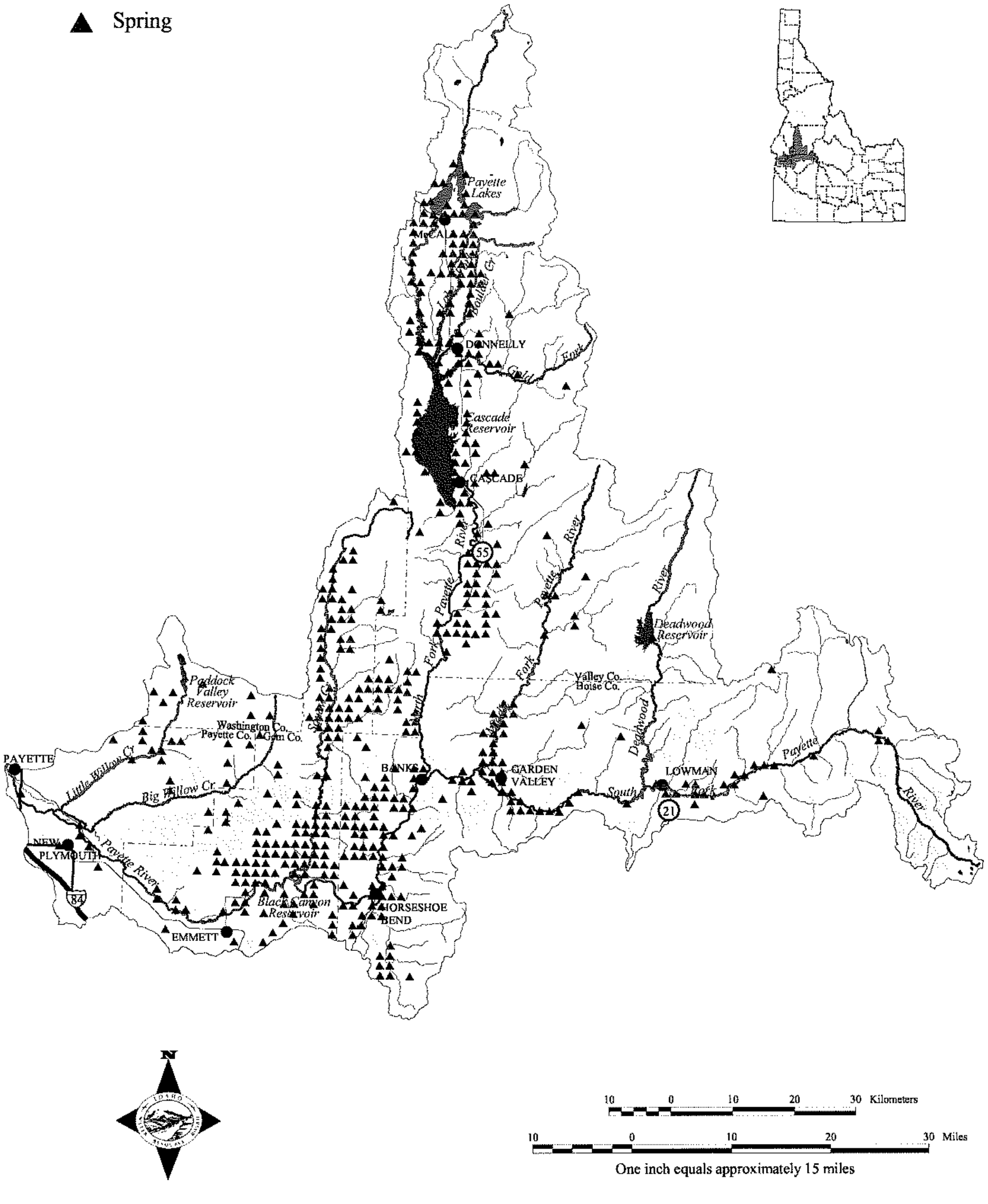
Geothermal Water Resources

In the Payette River Basin thermal water is encountered in rocks from Precambrian to Holocene age, and is used for many purposes discussed in the next section. Thermal springs issuing from granitic rocks appear in most instances to be associated with major regional fault structures, as demonstrated by their areal occurrence and alignment along major rivers. Thermal springs issuing from other rocks are randomly scattered, and probably are associated with local faulting (Ross, 1971; Mitchell, et al., 1980; Young, 1985). There are 31 thermal springs and 35 thermal wells identified in the Payette River Basin (Lewis and Young, 1980; Neely, 1997).

Thermal water in Idaho is generally defined as water with a temperature greater than 85°F. The temperature of geothermal water in the basin averages 100°F, but is as high as 250°F in several wells (Neely, 1997). Mitchell and others (1980), and Young (1985) estimated the subsurface or reservoir temperatures of several hot springs in the basin at more than 300°F.

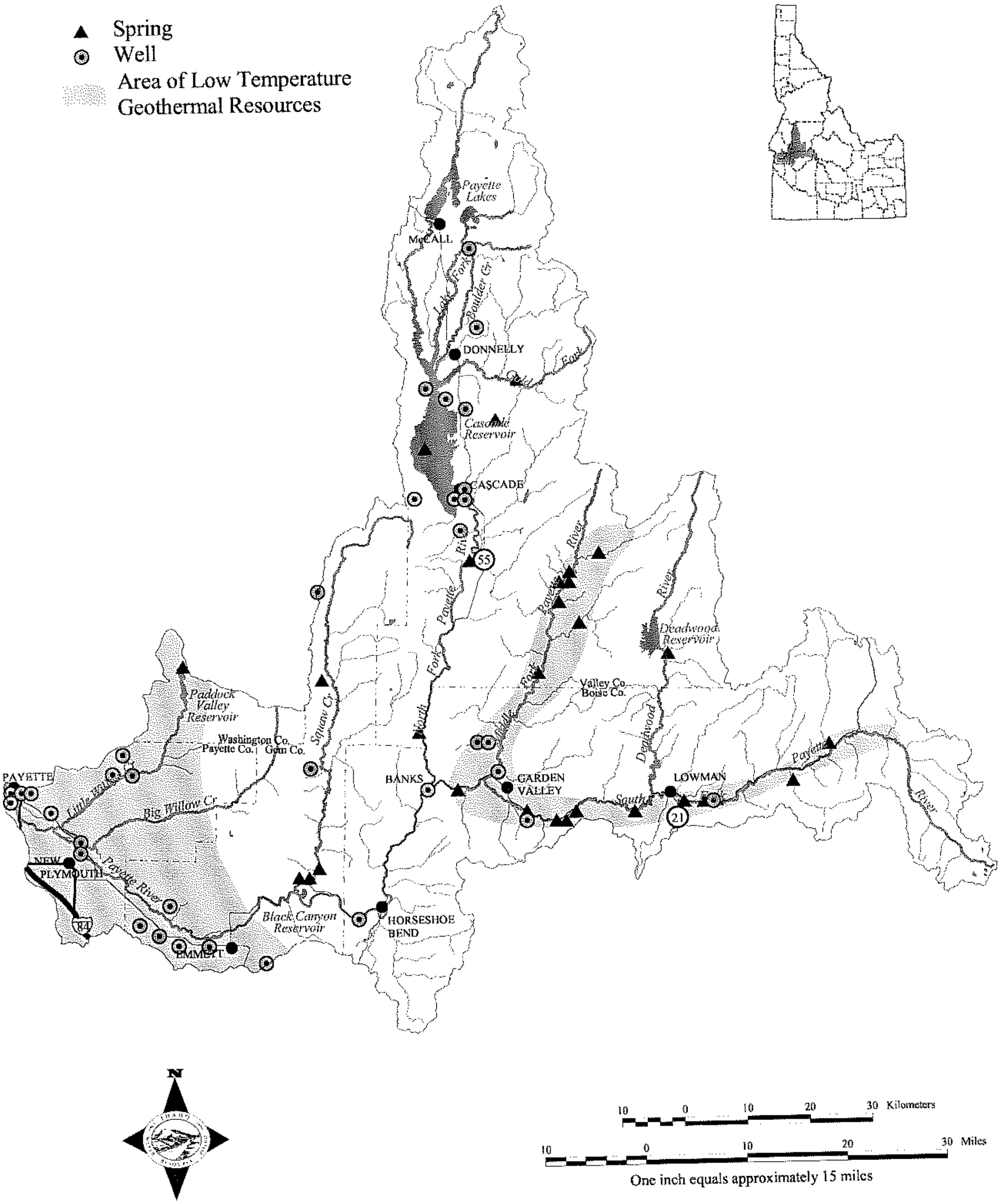
Thermal water discharge in the Payette River Basin ranges from less than one gallon-per-minute to over 500 gallons-per-minute (Lewis and Young, 1980; Mitchell, et al., 1980). Thermal springs discharge about 5,700 acre-feet of water annually (Lewis and Young, 1980). Map 9 shows the locations of identified thermal springs and wells in the Payette River Basin, and general areas of low temperature geothermal resources identified by the Idaho Department of Water Resources (Mitchell, et al., 1980; Neely, 1997).

Map 8. Springs



y:\payette\arcview\projects\projects2\gwater.apr (8/16/98)

Map 9. Geothermal Sources



y:\payette\arcview\projects\projects2\gwater.apr (8/31/98)

There are more than a dozen thermal springs and wells in the Cascade-Gold Fork area. The hottest water (140°- 160°F) is at Cabarton Hot Spring. This spring flows about 60 gallons-per-minute from a coarse granite at the intersection of two faults (Ross, 1971). Two thermal springs are now covered by Cascade Reservoir.

More than a dozen thermal springs occur along the 60-mile east-west lineament that marks the South Fork Payette River (Ross, 1971; Young, 1985; Mitchell, et al., 1986 and 1991). All the springs are in granitic rocks, and have similar geologic occurrences and water chemistry. Although temperatures are variable (37° to 67° C), the water chemistries are amazingly similar (Lewis and Young, 1980). Total dissolved solids only range from 216 to 270 milligrams per liter - a very narrow range for water samples collected over a reach about forty miles in length. Specific conductances, alkalinity, and individual water quality variables also show results with very limited variability.

Temperatures are relatively high; the lowest is 124°F and most are greater than 140°F. The hottest water is at Bonneville Hot Spring on Warm Spring Creek. The thermal spring yields 350 gallons-per-minute of 187°F water from a fault in granite (Ross, 1971). Chemical geothermometers indicate that subsurface temperatures cool along a fairly systematic gradient from a high at Bonneville Hot Springs in the upper reach of the South Fork Payette River to a low near Danskin Creek Hot Springs. However, temperatures rise again to the west. Deer Springs, four miles west of Garden Valley, has a surface temperature of 178°F.

Eight thermal springs flow from granitic rocks along shear zones paralleling the Middle Fork of the Payette. Springs along the Middle Fork seem to lie along an extension of the same fault that acts as a conduit for springs along the South Fork of the Salmon River (Ross, 1971; Mitchell, et al., 1980). The hottest water (183°- 192°F) is at Boiling Springs. This spring discharges approximately 150 gallons-per-minute from coarse granite at the intersection of two faults (Ross, 1971). Thermal springs and many thermal wells are also located in the Garden Valley-Crouch area.

In the lower Payette River Basin, five springs and nineteen wells produce thermal water. Most wells in the lower basin tap water within a temperature range of only 68°- 84°F. However, the Rassmussen well in the Little Willow Creek drainage, with a depth of over 4,000 feet, produces water at 267°F (Neely, 1997). Generally, the deeper the well in the lower basin, the hotter the water. This also applies to hot springs. While the surface temperature of Roystone Hot Spring near Emmett is only 160 °F, Young (1985) calculates the deeper reservoir temperature of the hot spring at over 300°F. This temperature calculation is substantially higher than other basin thermal reservoir temperature estimates.

Water Allocation and Use

Water resources in the Payette River Basin have been extensively developed and appropriated for irrigation, power generation, domestic, commercial, municipal and industrial supply, wildlife, recreation and aesthetics, among others. Water allocation and use examines the use of water from two perspectives. First, the administrative allocation of water in the Payette River Basin for beneficial use by the Idaho Department of Water Resources is examined. Secondly, a description of specific water use categories is provided, including an estimate of the quantity of water associated with these uses.

WATER ALLOCATION

The constitution and statutes of the state of Idaho declare all the waters of the state, when flowing in their natural channels, including ground waters, and the waters of all natural springs and lakes within the boundaries of the state, to be public waters. The constitution and statutes also guarantee the right to appropriate the unappropriated public waters of the state of Idaho, and it is the state's duty to supervise that appropriation and allotment [Idaho Code 42-101]. Water appropriations are administered by the Idaho Department of Water Resources following the prior appropriation doctrine, best described as "first in time - first in right."

The prior appropriation doctrine is a system of water law adopted by most western states. A water right is the right to divert the public waters of the state of Idaho, and put them to beneficial use in accordance with one's priority date. Water rights are issued by date of appropriation for specific quantities, diversion points, places of use, and purposes. Changes in water rights, such as diversion point or use, require application to and approval by the Idaho Department of Water Resources. If a change exceeds 50 cubic feet per second or 5,000 acre-feet, the change must be approved by the Idaho Legislature.

Surface and ground water rights in the Payette River Basin were decreed in a court of law as part of an adjudication begun in 1969, reviewing all water right claims filed before October 19, 1977. About 10,500 claims were filed. Partial decrees were issued, beginning in 1986 through 1990, for all but about 90 of the water right claims. With the exception of the Forest Service federal reserved right claims (approximately 49), the remainder have been resolved and are waiting for a decree to be issued.

The current Snake River Basin Adjudication will also examine water rights in the Payette River Basin. This process was prompted by the 1984 Swan Falls agreement between the state of Idaho and Idaho Power Company. Consequently, the Idaho Legislature determined that an adjudication of the entire Snake River Basin was in the public interest, and should proceed subject to the stated constraints regarding federal reserved right claims [Idaho Code 42-1406A].

The solicitation of water right claims for the Snake River Basin Adjudication began in February 1988. The Payette River Basin is the Department's Administrative Basin 65. More than 11,000 water right claims were filed in Basin 65. Water rights decreed in the Snake River Basin Adjudication will supercede decrees issued in the Payette River Basin Adjudication. A Director's report was filed in April 1998 that makes recommendations to the Snake River Basin Adjudication Court for nearly 9,000 stock and domestic water rights. A director's report to address water right claims for other beneficial uses is planned for publication in July 2000.

Figure 26 displays patterns in water appropriations for irrigation and non-irrigation uses in the basin from pre-1900 to the present. The information reflects the priority date of water right licenses, permits, and decreed rights from the Payette River Basin adjudication. Many irrigation appropriations occurred before 1900 and during the 1930 to1939 period. These reflect water rights acquired by canal companies operating in the lower Payette basin, and appropriations for U.S. Bureau of Reclamation projects, including Cascade, Deadwood and Black Canyon facilities. Surface water accounts for more than 98 percent of the basin's irrigation appropriations. Irrigation ground water appropriations have steadily increased over time, with this trend most noticeably beginning in the 1950s.

Non-irrigation appropriations include domestic, commercial, municipal, industrial, livestock, fish propagation, and other uses. Appropriations (in terms of flow rate) have been greatest in the period from 1960 to 1989, coinciding with population growth

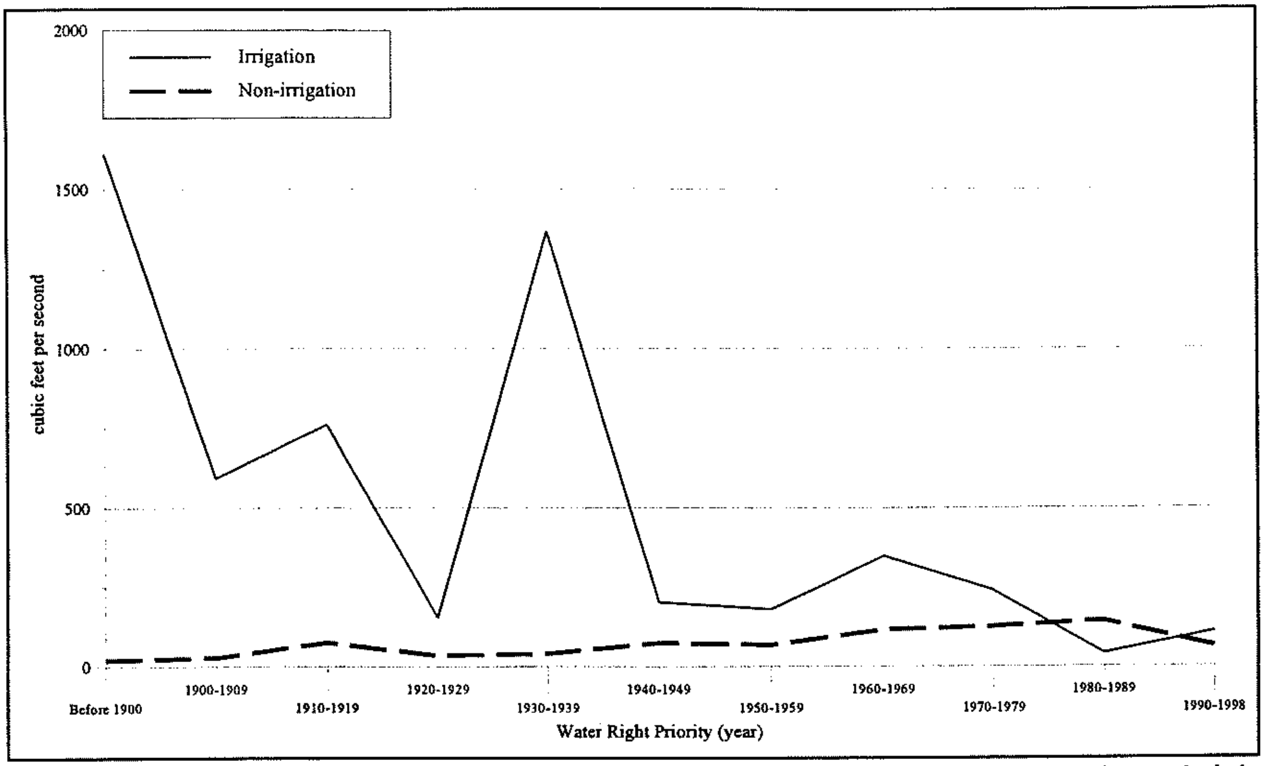


Figure 26. Water Appropriations in the Payette River Basin (in cubic feet per second). ***Note: The figure does not include hydropower or minimum stream flow appropriations.*** (Derived from a review of Idaho Department of Water Resources Water Rights Database).

in the basin. Total appropriations for non-irrigation uses are almost equally split between surface and ground water sources. Non-irrigation ground water appropriations exceed irrigation ground water appropriations in most decades.

Hydropower and minimum stream flow appropriations are not depicted in Figure 26. The major hydropower appropriations occurred in the 1920s reflecting the power development at Cascade and Black Canyon dams, in the 1970s reflecting the increased capacity at the Cascade hydropower facility, and in the 1980s for the Horseshoe Bend hydropower project. All approved minimum stream flow appropriations in the basin occurred in the mid to late-1980s when the Board filed applications for instream flows on reaches of the North Fork and South Fork Payette rivers (See Table 53, page 168).

Figure 27 summarizes the estimated volume of major surface and ground water right appropriations in the Payette River Basin as of 1998. Figure 27 does not include hydropower or minimum stream flow appropriations, as these are instream non-consumptive uses. The figure also excludes other non-consumptive uses and some minor consumptive use appropriations. These appropriation numbers do not equate to actual water use, but instead represent the sum of the water right licenses, permits, decrees, claims, and applications in the water rights database of the Idaho Department of Water Resources. They show a potential and theoretical maximum diversion that could be used under the rights. Total quantity appropriated exceeds actual water supply, as some water rights appropriate the return flows from water diverted upstream, are for non-consumptive uses, or have junior priority dates.

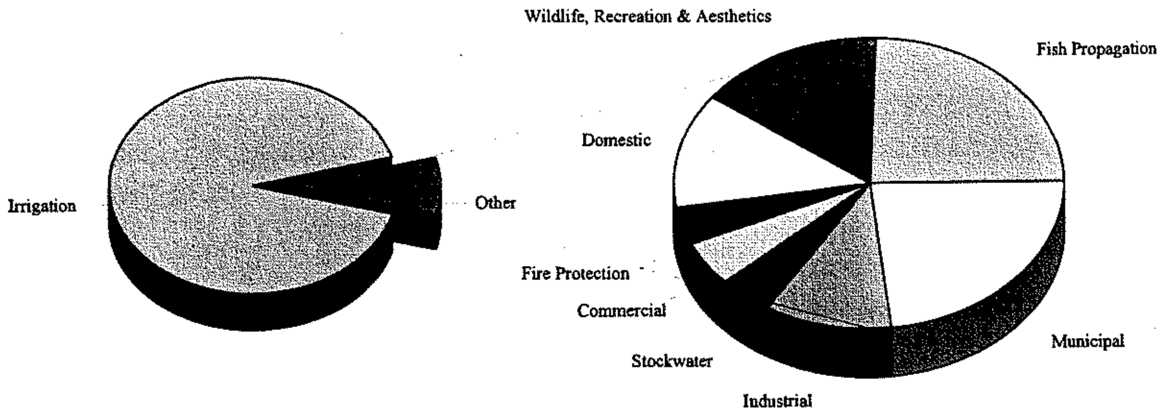


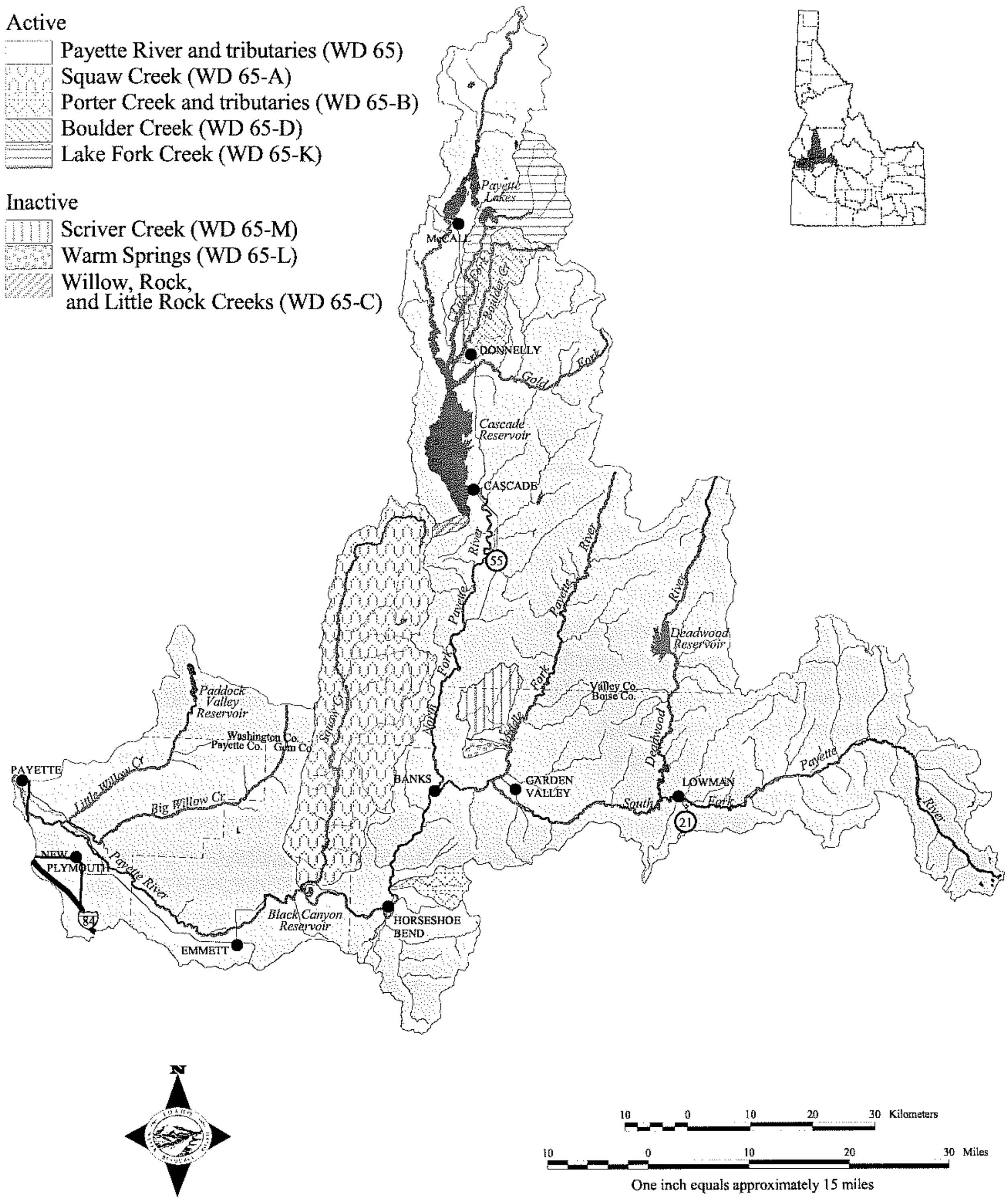
Figure 27. Water Appropriations in the Payette River Basin Based on Water Rights (in percent of estimated volume). ***Note: Hydropower and minimum streamflow water rights are not represented.*** (Derived from a review of the Idaho Department of Water Resources Water Rights Database.)

Water appropriations in the basin indicated in Figure 27, and excluding those mentioned above, total almost 2.3 million acre-feet. This represents the estimated volume of water that could legally be used under the water right license, if it were available. About one percent of these (based on volume) rely on ground water. Irrigated agriculture comprises ninety-one percent of this total. Municipal water supplies and fish propagation comprise the next largest water use, each encompassing about two percent of the total. (Fish propagation consists of hatcheries or fish ponds). Hydropower and minimum stream flow rights would add another 8.9 million acre-feet of non-consumptive use.

Water districts are created by the Director of the Idaho Department of Water Resources for areas that have been adjudicated by a court of law [Idaho Code 42-604]. Watermasters are responsible for distributing water in the district according to the water right priorities under the supervision of the Department. Water users in the water districts annually elect a watermaster who is then appointed by the Director of the Department. Eight water districts were created in the Payette River Basin. Three of these are inactive including the Willow, Rock and Little Rock Creeks - Water District 65C; Warm Springs - Water District 65L; and Scriver Creek- Water District 65-M. Water district boundaries are depicted in Map 10.

The majority of surface water in the basin is distributed through Water District 65, encompassing the portion of the Payette River Basin outside the other six water district boundaries. Water distribution in Water District 65 is accomplished through use of an automated accounting program, developed and housed in the Idaho Department of Water Resources. On a regular basis the watermaster calculates the amount of natural flow available, total

Map 10. Water Districts



y:\payette\arcview\projects\projects2\manage.apr (11/3/98) diversions, and the amount of contract storage water used by each space holder. Measurements of flows and diversions are obtained from an automated system operated by the U. S. Bureau of Reclamation, known as the HYDROMET, which monitors several river gages. Additional information is obtained from automated headgates in the basin. Data not available through automation are acquired from measurements made by ditch riders, or estimated based on power records. Approximately one million acre-feet of water, predominately for irrigation, was delivered within Water District 65 in water year 1996 (November 1, 1995 to October 31, 1996). This quantity varies each year, depending on water demand and availability. Factors affecting availability are precipitation, snowpack, and carry over of storage.

WATER USE

Although irrigation is by far the largest consumptive use of available water in the basin, other offstream and instream water uses are important to the area's economy. Processing and manufacturing industries depend on an ample supply of good quality water. Municipal water supplies, hydroelectric power generation, fish, wildlife and the recreation/tourism industry in the basin are dependent on river flows, spring flows, lake and reservoir levels, and good quality water. Though small relative to other uses, domestic, commercial, industrial, and stock water use are essential to residents of the basin. Table 14 summarizes the estimated volume of water use within the Payette River Basin in 1996 by type of use.

Irrigated Agriculture Water Use

The Payette Valley is one of the most productive agricultural areas in Idaho. Over forty different crop varieties are grown in the basin under numerous types of irrigation systems. Based on acres harvested, major crops are alfalfa, wheat, sugar beets, and assorted fruits and vegetables (corn and onions). These commodities provide the raw products for food and seed processing plants located throughout the area.

Irrigation of agricultural land accounts for about 97 percent of offstream water use in the Payette River Basin. In 1996 about 190,000 acres were irrigated using more than 1.15 million acre-feet of Payette River Basin water, of which about 43,000 acres are located in the Boise River Basin (U.S. Department of Agriculture, 1996; Idaho Department of Water Resources 1998; Orr, 1998). About 281,000 acre-feet was diverted into the Boise River Basin (Orr, 1998). Map 5 shows most of the irrigated acreage in the Payette River Basin is located in two areas: (1) the

Table 14. Estimated Water Used by Categories in the Payette River Basin for 1996 (acre-feet).

Water Use	Acre-feet
Irrigated agriculture	1,155,546[1]
Stock water	1,231
Domestic/ Commercial / Municipal	11,188
Industrial	20,690
Power generation	4,021,708

[1] An estimated 281,000 acre-feet of this total is diverted for use in the Boise River Basin (Orr, 1998).
Source: Compiled by Idaho Department of Water Resources from various sources.

lower Payette Valley downstream from Emmett, and (2) Long Valley between McCall and Cabarton. The smaller irrigated areas, generally located in tributary valleys, commonly produce forage crops for livestock and small grains.

Based on estimated irrigation diversions for water year 1996, surface water supplies about 1.10 million acre-feet. Approximately 996,000 acre-feet are diverted from the Payette River and 107,000 acre-feet from tributaries. Ground water diversions supply an estimated 52,000 acre-feet to agricultural lands. About 75 percent of basin ground water withdrawals take place in the lower Payette Valley.

Twenty-seven canals and ditches, and 59 pumps divert and deliver water from the Payette River to irrigated farmsteads below Gardena (Howe, 1996). Map 11 shows major diversions and inflows comprising some of the water delivery network to these lands. Water from storage comprised about 13 and 21 percent of annual diversions below Gardena in 1995 and 1996 respectively. In low runoff years, such as 1994, storage provided 55 percent of annual diversions.

Surface water sources have been adequate to serve irrigation needs in average water years, and ground water has not been exploited to a significant degree. Water for irrigation is delivered through several large gravity canal systems developed by irrigation companies in the early 1900s. Virtually all the crop land is furrow irrigated, however, approximately 26,404 acres in the Payette River Basin are irrigated by sprinklers (McAndrews, 1992). For marketing and storage reasons, furrow irrigation is the preferred method of irrigating seed crops and onions.

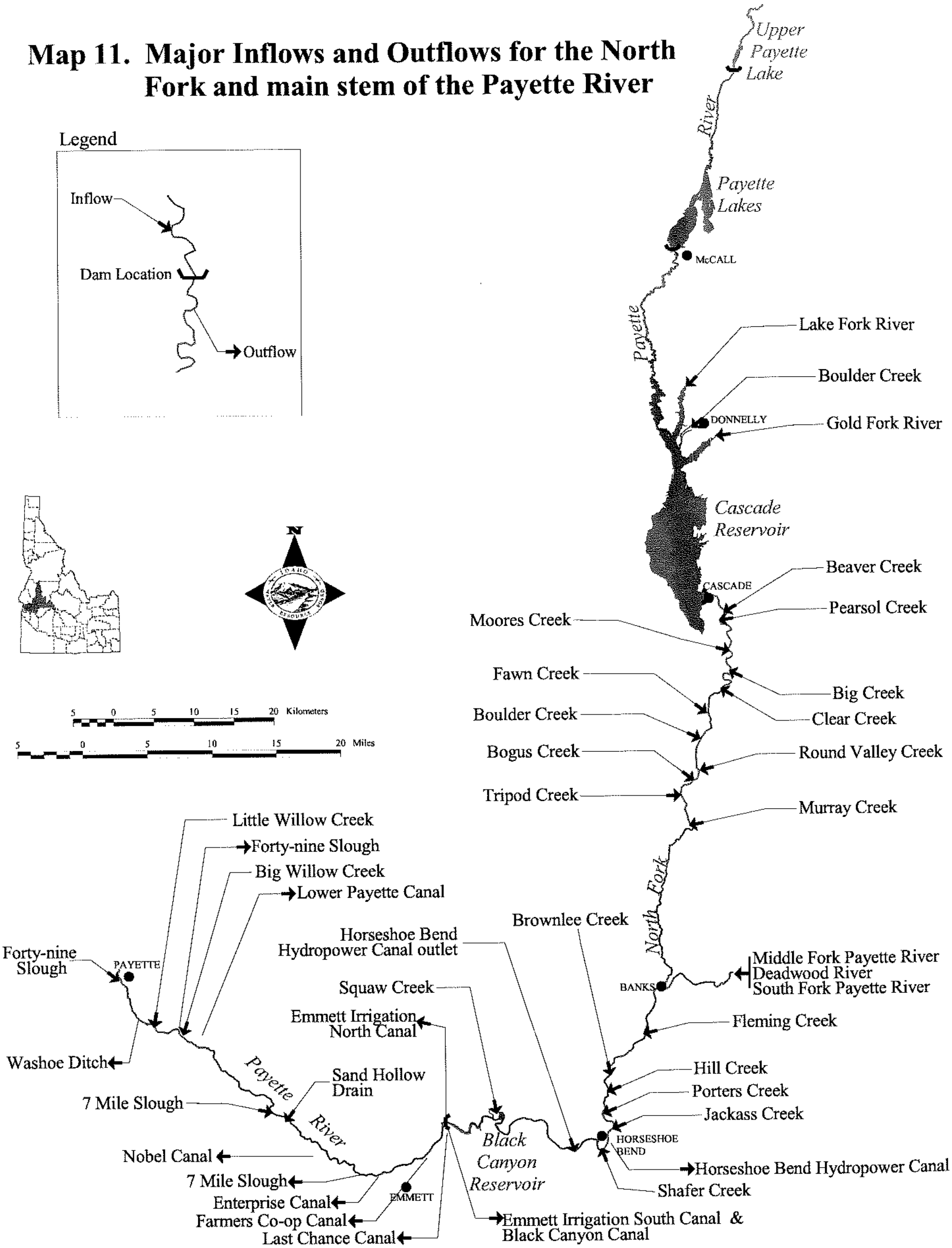
Irrigation requirements vary from year to year, depending on temperature, the amount and seasonal distribution of precipitation, and crop type. Winter, spring, and fall precipitation will reduce irrigation water withdrawals, if adequate soil moisture delays the start of irrigation in the spring or hastens its end in the fall. Scant precipitation during summer months has less effect on irrigation water withdrawals. Average crop consumptive irrigation requirements range from 1.33 acre-feet per acre annually for grains (barley, oats, and wheat) to 2.69 acre-feet per acre annually for alfalfa (U.S. Natural Resources Conservation Service, 1991). Generally, alfalfa, sugar beets, pasture, and potatoes have the highest consumptive water use rates in the basin.

The Idaho Department of Water Resources estimated irrigation water management efficiency in the Payette River Basin at about 32 percent for 1996. This was estimated by determining the consumptive water use for each crop type irrigated in the basin for that year. The amount of water applied to crops generally exceeds irrigation water requirements because of on-farm losses. Water evaporates from exposed water surfaces in gravity-distribution systems. Runoff and seepage occur when more water is applied than can be evapotranspired, or absorbed and retained by the soil. Water also seeps from unlined ditches.

Stock Water Use

Livestock numbers in the Payette River Basin total more than 70,000 head. About ten percent of the cattle are dairy cows and about 4.5 percent of livestock are sheep (Idaho Agricultural Statistics Service, 1996). Livestock enterprises are important in all parts of the basin, but they are relatively more important in the high valley areas. In these areas, practically all agricultural activities are associated with livestock production, with hay and pasture produced on private lands, and grazing on public lands.

Map 11. Major Inflows and Outflows for the North Fork and main stem of the Payette River



Livestock water use in the Payette River Basin is an estimated 1,231 acre-feet annually. Dairy industry withdrawals are an estimated 300 acre-feet of that total. As a general rule, one range cow consumes 10 to 15 gallons of water per day, but dairy cows require about 35 gallons-per-day (Moore, 1966).

Livestock water use includes water for both stock watering and other on-farm needs aside from irrigation. The U.S. Geological Survey estimates that approximately 60 percent of water used for livestock in the Payette River Basin is provided by ground water (Maupin, 1997). Livestock water supplies are usually developed by private individuals. On the range and in the mountains, livestock usually water freely from streams or springs unless watering stations have been developed.

Domestic, Commercial, Municipal and Industrial Water Uses

Domestic, commercial, municipal, and industrial water use is relatively small, but essential to human life and economic development. Domestic and commercial water use includes drinking, food preparation, washing, and lawn and garden watering. Municipalities supply water not only to residences and commercial enterprises, but also to schools, fire departments, and municipal parks. Industrial water use incorporates manufacturing processes, cooling, and employee sanitation.

Domestic, commercial, municipal, and industrial water demand is increasing due to population growth. The Payette River Basin's population has increased nearly 73 percent in the twenty-six years between 1970 and 1996. The cities, which are the fastest growing areas, may require new water supplies to provide for additional people. As the industrial potential of the area is developed, water requirements for industrial use will also increase. While the basin is not considered to be limited in water supply, most of the water is allocated to other uses. Locating additional supplies for domestic, municipal, commercial, and industrial uses may require administrative actions, policy changes, or reallocation to make additional water supplies available for these uses.

Ground water supplies at least 75 percent of the domestic, commercial, and municipal water demand in the basin. Exact water use quantities are difficult to define, because many individuals, businesses, and communities do not have water meters.

Withdrawals for domestic, commercial, and municipal water use in the Payette River Basin total an estimated 11,200 acre-feet per year (Idaho Department of Water Resources, 1998). Municipal and domestic estimates for the Payette River Basin were derived by summing documented annual water use for municipal systems with estimated use for the remaining population based on average water use per day. More than 50 percent of basin households rely on municipal or public drinking water systems. Forty-four percent use individual wells (Table 15). Public drinking water systems are water supply systems with ten or more hook-ups.

Municipal Water Supply and Uses

Many communities in the basin are trying to expand and upgrade their water systems. Improvements range from new wells, storage tanks, and pipelines to water treatment facilities. Some communities have paid for these improvements without outside help, but most have made use of public funding programs. Table 16 and the following section summarize municipal water supplies in the basin and projected demand.

Table 15. Source of Water for Housing Units by County.

Source	Boise	Gem	Payette	Valley	Basin Total
Public system or Private Co.	1,134	1,839	3,858	3,769	10,600
Individual Wells	1,322	2,794	2,633	2,533	9,282
Other	438	92	29	338	897

Source: U.S. Bureau of Census, 1990.

Table 16. Summary of Municipal Water Use and Needs.

Municipality	Population Served	Water Supply (Water Rights)	Peak System Capacity	Projected Ave. Demand (2010)	Water Source
McCall	2700 hook-ups	9.71 MGD	6.0 MGD	1.56 MGD	Payette Lake (primary) & groundwater
Cascade	6500 people	1.36 MGD 3.0 MGD (back-up)	1.87 MGD	0.66 MGD	ground water Campbell & Hazard Cr. (back-up)
Donnelly	95 hook-ups	1.6 MGD	0.059 MGD	0.05 MGD	ground water
Horseshoe Bend	321 hook-ups	1.43 MGD 0.70 MGD	0.50 MGD	0.31 MGD	Payette River groundwater (wells abandoned)
Emmett	2700 hook-ups	9.5 MGD	2.5 MGD	1.28 MGD	ground water
New Plymouth	657 hook-ups	2.99 MGD	2.66 MGD	0.45 MGD	ground water
Fruitland	1074 hook-ups	3.84 MGD	1.25 MGD	0.97 MGD	ground water
Payette	2300 hook-ups	6.64 MGD	2.23 MGD	1.31 MGD	ground water

MGD = million gallons-per-day

Source: Compiled by Idaho Department of Water Resources from various sources.

Current water supply for each municipality was derived from a review of water right appropriations for that community, and represents a best case estimate. Actual supply may be limited by infrastructure capacity, diversion rates, or the priority date of the water right. The peak capacity of the water supply system for each community is displayed in Table 16. Industry standards suggest peak capacity should be about 2.5 times the continuous usage rate. Projected demand was calculated by determining average daily per capita use based on current water use, and applying this number to the projected population for 2010. This number reflects the average daily use projected for 2010 and does not address peak demand. Appendix D contains maps delineating the water systems for these municipalities.

City of McCall

Current Water Supply: The City of McCall uses surface water from Payette Lake as its primary water source. In 1996 the city started construction of a water treatment plant to meet Safe Drinking Water Act requirements. Infrastructure upgrades included providing for storage, piping, isolation of the golf course, and meters to all units. Phase 1, consisting of water distribution improvements, pumping station modifications, and water treatment plant construction for disinfection, has been constructed. Phase 2 will require an additional $4 million to implement filtration (Kimball, 1997).

About 7 percent of the hook-ups serve commercial water users, including motels, restaurants, and other retail businesses. No major industrial users rely on the municipal system. Most areas outside city limits are on individual wells. Over 300 lakeside households are on independent water systems that draw their water supply from the lake (Johnson, 1996).

Projected Water Demand and Needs: The water treatment plant has a capacity of 6 million gallons-per-day which is the estimated peak demand for the year 2004 (Kimball, 1997). Preliminary review indicates the City has sufficient water rights to meet the 2004 estimated peak demand and the projected average daily demand to at least 2010. However, eight percent of water used in 1997 was purchased from the rental pool (See page 165, describing rental pools). The immediate need is funding to construct Phase 2 of the water treatment plant, so that McCall can meet drinking water standards. The City may need to examine whether current facility capacity will meet peak demands beyond the year 2004.

City of Donnelly

Current Water Supply: The City of Donnelly acquires its water supply from a well that taps the deep aquifer at a depth of 522 feet. This well was recently constructed with financial assistance from the Board. Previously, the City relied on three wells pumping from a shallow production zone. The water distribution system includes two storage tanks. Treatment involves disinfection by chlorination. Commercial users include several local businesses.

Projected Water Demands and Needs: Preliminary review indicates water rights are adequate to meet the water needs for projected population growth. However, the current peak capacity of the system may need to be reexamined to serve this growth.

City of Cascade

Current Water Supply: Water is supplied by four wells on the south end of Cascade Reservoir. The first of these wells was constructed with funding assistance from the Board. The remainder of the wells were constructed in 1996. Prior to 1988, Cascade relied on surface water from Campbell and Hazard creeks treated in the West Mountain water treatment plant. This facility is now used as a back-up supply. A small dam at Skein Lake also diverted water into this plant in the past, but is no longer functional.

Projected Water Demand and Needs: Cascade currently has ground water rights to provide up to 1.36 million gallons-per-day. Projected peak water demand for 2010 is 1.6 million gallons-per-day. To meet future water demands Cascade either needs to acquire additional ground water rights, or invest in expensive upgrades to the West Mountain treatment plant to allow its surface water to be used as a primary water supply.

Horseshoe Bend

Current Water Supply: Horseshoe Bend's water supply system was constructed in 1968. Originally five wells tapping into the shallow aquifer supplied municipal water. The community began to divert water from the Payette River in 1976, because of water quality problems with the wells. The flow of the Payette River is not adequate to provide water at all times given the junior priority date of the water right. Horseshoe Bend has had to purchase water from the rental pool to meet demand when its Payette River water right is not in priority. In 1996 Horseshoe Bend purchased one-third of its water supply from the rental pool. The city recently completed a water treatment plant upgrade to process Payette River water to meet Federal Safe Drinking Water Act standards. A major industrial user was the Boise Cascade Corporation, but the mill closed in September 1998.

Projected Water Demand and Needs: The junior water right requires purchase of water from the rental pool, raising concerns about the lack of a secure supply of water to meet current and future demand. Horseshoe Bend needs to examine securing a water right with a senior priority date, or some other avenue to obtain a more secure water supply. Closure of Boise Cascade's mill is estimated to reduce current water demand by 10 to14 percent. Associated economic impacts from mill closure, such as people moving to other areas to pursue work, and reduced property taxes, may affect Horseshoe Bend's ability to pay the long-term debt incurred for the recently completed water treatment plant.

City of Emmett

Current Water Supply: The City of Emmett relies on four primary wells and two back-up wells for municipal water supply. There are no major commercial or industrial water users relying on the municipal water supply. The cemetery and golf course are irrigated with separate wells. Schools are the major water users.

Projected Water Demand and Needs: A preliminary review indicates the City of Emmett has sufficient water rights to meet projected demand. Infrastructure needs include minor remodeling of the mixing capacity for water treatment and more water storage capacity (Evans, 1998).

City of New Plymouth

Current Water Supply: The City of New Plymouth obtains its water supply from four wells, one of which is used for back-up only. In 1995 the Board helped reduce demands on the municipal water system by assisting in financing the development of an alternative surface water source to irrigate the City's thirteen acre park. In November 1997 the city undertook a major water system improvement project that included construction of a new well, 300,000 gallon storage tank, and replacement of many water mains. These upgrades were designed to accommodate population growth through 2017.

Projected Water Demand and Needs: New Plymouth has a water right and water right claims totaling almost 3 million gallons-per-day. Water quality from the wells complies with current Safe Drinking Water Act requirements without treatment. No immediate need for additional infrastructure or water supply is foreseen.

City of Payette

Current Water Supply: Municipal water is supplied by seven wells. A separate well irrigates the golf course. In 1996 the major industrial user, a food processor, used forty percent of municipal water delivered (Gabiola, 1997).

Projected Water Demand and Needs: A preliminary review indicates the City has adequate water rights to meet projected demand. Examination of peak system capacity to meet projected future demands may be beneficial.

City of Fruitland

Current Water Supply: The City of Fruitland relies on ten wells to provide municipal water. Eighty percent of the water comes from the wells tapping the shallow aquifer at about 70 feet (Campbell, 1997). The City currently has a water right permit to appropriate water in the deeper aquifer at a depth of about 400 feet. About 25 percent of water delivery in 1996 was to the two major industrial users in Fruitland -- the Coca Cola bottling plant and a frozen food processor.

Projected Water Demand and Needs: A preliminary review indicates the City of Fruitland has sufficient water rights to meet projected demands. The peak production of the current water supply system (1.25 million gallons per day) equates to 1.6 times the continuous usage rate (0.78 million gallons per day). The City will probably have to upgrade system capacity to meet peak water demands and fire protection flows.

Industrial Water Uses

The food processing and timber industries are the primary industrial water users in the Payette River Basin. The industrial water requirement in the basin is approximately 20,600 acre-feet annually. Most large industrial water users have developed independent ground water supplies, although municipal or public supply systems deliver to some manufacturing uses in Fruitland and Payette.

Food-processing industries withdraw relatively large volumes of water for meat packing and fruit and vegetable preparation and preservation. Withdrawals for food processing have a distinct seasonal pattern. Water use for potato processing is highest from September through March. Water use for canning and freezing of fruits and vegetables peaks from July through October. Water use for milk- and meat-processing industries is relatively constant throughout the year.

Fish production, or aquaculture, in the Payette River Basin uses, non-consumptively, an estimated 15,000 acre-feet of water per year (Maupin, 1997). There are two licensed fish producers in the Payette River Basin, and a federal hatchery facility at McCall on the North Fork Payette River which is operated by the Idaho Department of Fish and Game. The two private fish producers in the basin raise fish for pond stocking and fee fishing. The federal hatchery at McCall raises summer chinook salmon for release in the South Fork Salmon River. The facility also serves as a redistribution center for rainbow trout and a rearing facility for westslope cutthroat trout. The rainbow and westslope cutthroat trout are released in the region's high mountain lakes (Rogers, 1997).

The forest products industry requires water for lumber and wood products manufacturing, and storing and moving logs. Water rights have also been acquired for fire protection.

Sand and gravel processing is the primary use of water in the basin by the mining industry. Water is essential in mining and processing minerals, however, total water requirements of the industry are small. The U.S. Department of the Interior has estimated that the mining industry consumes less than one-half of one percent of all diverted water, and recycles the same water several times (U.S. Geological Survey, 1991). The mining or minerals industry in the Payette River Basin diverts an estimated 200 acre-feet annually (Maupin, 1997).

Water Used for Power Generation

More than 4 million acre-feet passed through hydropower plants located at Cascade Reservoir Dam, Horseshoe Bend, and Black Canyon Dam in 1996. This quantity was estimated by comparing power plant capacity with river flows occurring below these hydropower plants. An assumption is that each plant diverts up to its maximum capacity through its turbines. Most hydropower plants in the basin operate as run-of-the river, meaning water is not released from storage reservoirs specifically for power generation. An exception is a minimum 200 cubic feet per second release from Cascade Reservoir to fulfill Idaho Power Company's natural flow right for power generation.

Idaho Power Company's Power Plant at Cascade Dam can divert up to 2300 cubic feet per second through its turbine. The Horseshoe Bend Power Plant diverts flows above 420 cubic feet per second, and up to 3500 cubic feet per second, into its power canal. The hydropower plant capacity at Black Canyon Dam is 1600 cubic feet per second.

Geothermal Water Use

Geothermal energy has been used in southwest Idaho since human occupation. Table 17 summarizes current geothermal water use in the Payette River Basin. Space heating is the most common use of geothermal water in the basin in terms of number of developments. The largest quantity of geothermal water is used for fish production and recreational uses. Several hot spring resorts operate in the basin. The U.S. Forest Service uses hot springs for shower facilities at some campgrounds. Greenhouse operations using geothermal energy are located on the South Fork Payette River. Stock watering in winter is another important use.

Water Development and Management

IRRIGATION STORAGE DEVELOPMENT

Since the early part of the century, the need for water storage to supplement natural flows during the irrigation season was recognized in the Payette River Basin. In 1902 the first storage project in the basin was completed by the Roseberry Irrigation District at Boulder Lake. Paddock Valley Reservoir was the first storage project in the lower basin, constructed on Little Willow Creek in 1917 by the Little Willow Irrigation District. In 1921 the Lake Reservoir Company, representing the Emmett Irrigation District, the Farmers' Cooperative Ditch Company, the Enterprise Ditch, the Letha Irrigation District, and the Lower Payette Canal Company, installed outlet works to store water and control releases at Payette Lake. In 1926 storage was added to Little Payette Lake with the construction of an earth and rockfill dam at the outlet.

Federal water development projects were constructed in the Payette River Basin by the U.S. Bureau of Reclamation as part of the Boise Project. The Boise Project, encompassing the Payette Division, Boise Division, and Succor Creek Division, was proposed in 1905. The irrigation service area for the Boise Project encompasses a total 400,000 acres, with 120,000 acres located in the Payette River Basin (U.S. Bureau of Reclamation, 1996).

Portions of the Boise Project located in the Payette River Basin include Black Canyon Dam (a diversion dam) and two storage facilities (Cascade and Deadwood reservoirs). Information about these facilities are provided in Table 18. Black Canyon Dam was constructed in 1924 as a diversion structure for

Table 17. Estimated Geothermal Water Use in the Payette River Basin, 1995.

Use	No. of Developments	Estimated Annual Use (acre-feet)
Fish Production	1	40,000
Recreation	38	14,200
Space Heating	300	8,600
Greenhouse	10	6,200
Stock Water	13	230

Source: Derived from a review of the Idaho Department of Water Resources Water Rights and Adjudication Claims databases.

Table 18. Payette River Basin Water Storage Projects with a Capacity Greater than 250 Acre-feet.

Name	Owner or Operator	Stream	Storage Capacity (acre-feet)	Purpose*
North Fork Payette Subbasin				
Blackhawk Lake	LB Industries, Inc.	Duffner Creek	1,630	I
Boulder Lake	Roseberry Irrigation District	Boulder Creek	1,800	I
Boulder Meadow	Private	Boulder Creek	550	I
Box Lake	Lake Reservoir Company	Box Creek	1,295	I
Browns Pond	Private	Lake Fork	1,043	I
Cascade	US Bureau of Reclamation	NF Payette	653,200	IFP
Corral Creek	Private	Corral Creek	560	I
Davis	Private	Mud Cr & Pearsol Cr	1,200	I
Herrick	Private	Skunk Creek	562	DI
Horsethief	Idaho Department of Fish and Game	Horsethief Creek	4,900	RHG
Granite Lake	Lake Reservoir Company	Lake Creek	2,900	I
Jemima K	Private	W Fk Beaver Creek	3,000	I
Jug Creek	Jug Creek Reservoir, Inc.	Jug Creek	1,132	SI
Knox Meadow	Private	Lake Fork	1,073	I
Little Payette Lake	Lake Fork Irrigation District	Lake Fork	17,000	I
Louie Lake	Boulder Irrigation District	Louie Creek	400	I
Payette Lake	Lake Reservoir Company	NF Payette	41,000	I
Tom J	Private	Beaver Creek	2,950	I
Upper Payette Lake	Lake Reservoir Company	NF Payette	3,000	I
South Fork Payette Subbasin				
Deadwood	US Bureau of Reclamation	Deadwood River	161,900	ICR
Main Payette Subbasin				
Black Canyon	US Bureau of Reclamation	Payette River	29,822	IP
Bettis	Private	Dry Creek	1,060	I
Hidden Lake	Hidden Lakes, Inc.	Padget Creek	375	RH
Little (Van Duesan)	Private	Bissell Creek	1,228	SI
Paddock Valley	Little Willow Creek Irrigation District	Little Willow Creek	36,400	I
Sage Hen	Squaw Creek Irrigation	Sage Hen Creek	5,210	DI

* D = Domestic; F = Flood Control; G = Wildlife Propagation; H = Fish Propagation; I = Irrigation; P = Power; R = Recreation; S = Stock water

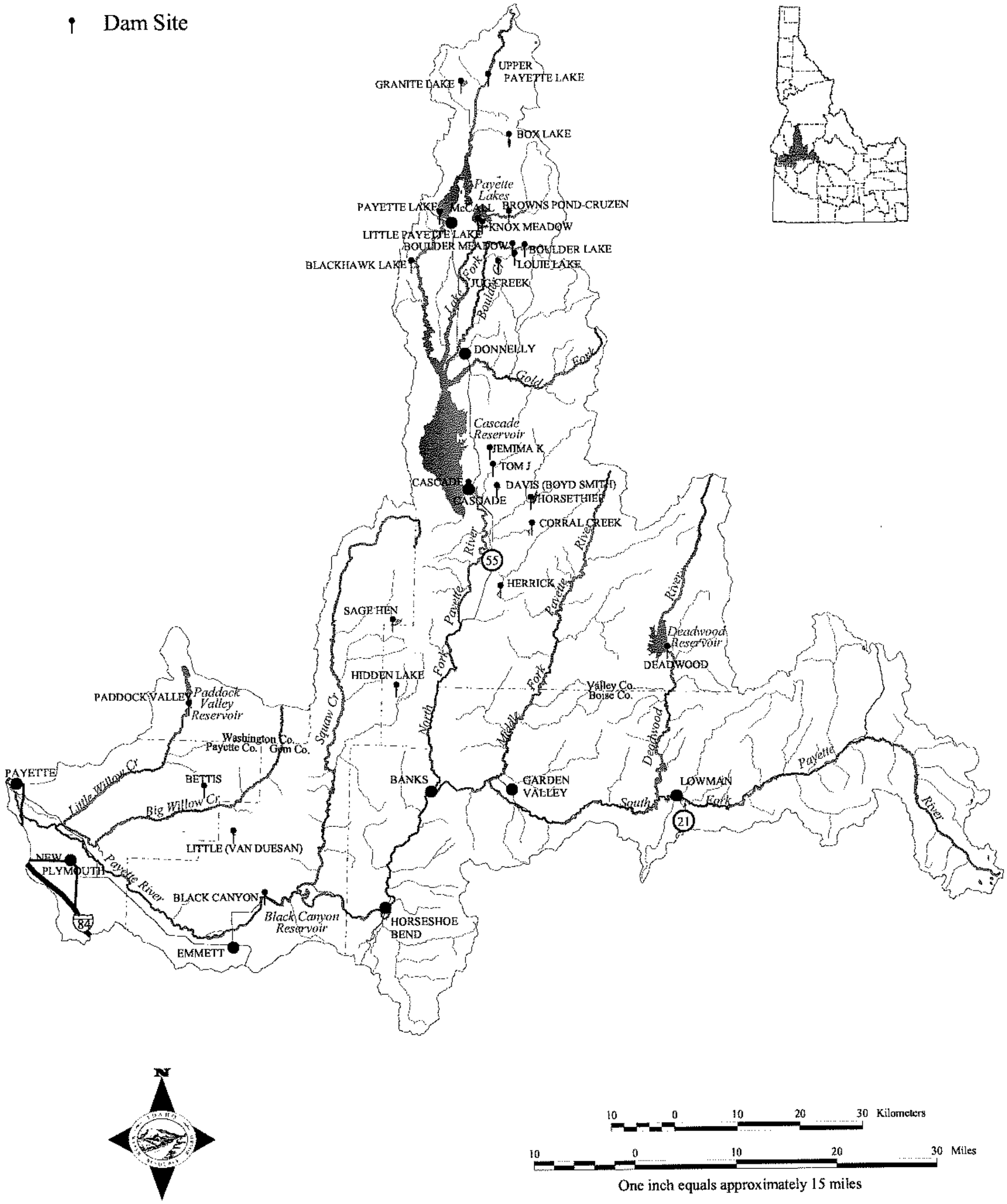
Source: Derived from the Idaho Department of Water Resources Dam Safety and Water Rights databases.

the Black Canyon Canal. Deadwood Dam, completed in 1931, was the first major storage structure on the Payette River. The project was built to store water to generate electricity at Black Canyon Dam to power project pumps. Cascade Dam was constructed on the North Fork Payette in 1946-48.

WATER STORAGE

In 1996 reservoir storage space in the Payette River Basin totaled more than one million acre-feet. Cascade Reservoir, on the North Fork of the Payette River, is the largest reservoir in the basin with a total capacity of 704,000 acre-feet. Map 12 displays the location of Payette River Basin reservoirs with a storage capacity greater than 250 acre-feet. Table 18 lists ownership, water source, storage capacity, and project purpose. Thirty-eight smaller reservoirs also impound basin runoff with storage capacity ranging from 4 to 200 acre-feet and averaging 70 acre-feet.

Map 12. Dams with Reservoir Capacity greater than 250 acre-feet



y:\payette\arcview\projects\projects2\struct.apr (8/16/98)

Potential Reservoir Sites

Population growth and economic development will bring additional demands on the basin's water resources. The construction of additional reservoirs may be needed to improve flood management, or accommodate growing municipal demands. Table 19 provides an initial inventory of potential reservoir sites identified in past investigations. Sites that were identified for hydropower, but show some potential for storage are included. None of these sites have been evaluated for economic or environmental feasibility. The Gold Fork site is reserved as a potential storage reservoir in the Board's 1996 *Idaho State Water Plan*.

FLOOD MANAGEMENT

Flood control operation on the Payette River relies on upstream storage at Cascade and Deadwood reservoirs, and a system of levees along the lower reaches of the Payette River. Although flood control was not included in the authorized purposes of Cascade and Deadwood dams, the U.S. Bureau of Reclamation makes releases from these dams by an informal agreement according to flood control rule curves (U.S. Bureau of Reclamation, 1996). Releases from Cascade and Deadwood reservoirs are coordinated in an attempt to limit flows at Horseshoe Bend to 12,000 cubic feet per second. This is not always possible as 65 percent of the basin is not regulated. Reservoir releases for flood control are dependent on the amount of storage that must be evacuated with respect to runoff forecasts. Flood control operations designate 80 percent of flood control space to Cascade Reservoir and 20 percent to Deadwood Reservoir (U. S. Bureau of Reclamation, 1996 and 1997).

Cascade and Deadwood reservoirs reduced the flood peak at Emmett in 1964 by nearly 9,000 cubic feet per second, and in 1997 reduced the peak at Emmett by approximately 14,000 cubic feet per second (Wells, 1997). However, runoff from areas below 5,000 feet in elevation have produced the largest flood-stage flows. There is no regulation of low elevation runoff. Flood regulation by these reservoirs decreases above the 100-year recurrence interval, and is uncertain to non-existent at the 500-year recurrence interval (U. S. Army Corps of Engineers, 1982).

A series of levees are located along the Payette River from Horseshoe Bend to its mouth. Map 13 (page 71) depicts ownership and location of these. These levees were built by individuals or the U.S. Army Corps of Engineers, usually under emergency situations. Levees in Horseshoe Bend were constructed by the U.S. Army Corps of Engineers in 1965 and 1969 (Federal Emergency Management Agency, 1984). These levees are considered temporary by the U.S. Army Corps of Engineers and unsuitable for protection for large flood events (Federal Emergency Management Agency, 1988). There are at least fifteen levees in Gem County constructed before 1977 in response to floods (Federal Insurance Administration, 1977).

Specific information about level of protection and year of construction for most levees is lacking. Seven jurisdictions currently have responsibility for maintaining the levees located in the basin as indicated on Map 13. Lack of funding and coordination between jurisdictions has reduced the effectiveness of levee protection. Numerous levees were damaged or failed during the most recent flood that occurred in 1997 (Interagency Hazard Mitigation Team, 1997).

All counties within the basin and all communities, except Crouch, participate in the National Flood Insurance Program. The program was established in 1968 by the National Flood Insurance Act, making flood insurance available to homeowners. To participate, communities or counties

Table 19. Potential Reservoir Sites Identified in the Payette River Basin.

Project Name	Stream	Identified Use	Dam Height (in feet)	Storage (acre-feet)
North Fork Payette Subbasin				
Bogus Creek	North Fork Payette	Power		33,000
Squaw Meadow	North Fork Payette			
Upper Lake	North Fork Payette	Power	95	49,000
Tamarack Falls	North Fork Payette	Power	<35	20,000
Gold Fork	Gold Fork			79,700
Louie Lake	Louie Creek		25	
Round Valley Creek	Round Valley Creek			
Scott Valley	Big Creek			
Big Creek	Big Creek			
South Fork Payette Subbasin				
Steep Creek	South Fork Payette	Power		
Canyon Creek	South Fork Payette	Power		
Grand Jean	South Fork Payette	Power		88,000
Big Pine Creek	South Fork Payette	Power		
Casner Creek	South Fork Payette	Power		
Archie Creek	South Fork Payette	Power		
Elk Lake	South Fork Payette	Power		
Clear Creek	Clear Creek	Power		
Pine Flat	South Fork Payette	Power		
Fogus	Canyon Creek	Power		
Garden Valley	South Fork Payette	Irrigation		1,940,000
Cloverleaf	Deadwood	Power		
Scott Creek	Deadwood	Power		
Rocky Canyon	Middle Fork Payette	Power	150	
Boiling Springs	Middle Fork Payette	Power		
Peace Valley	Silver Creek	Power		13,000
Main Payette Subbasin				
Bissel Creek	Bissel Creek	Offstream Storage	258	153,500
Montour Valley	Payette	Power		
Big Willow Creek	Big Willow Creek	Irrigation		6,500

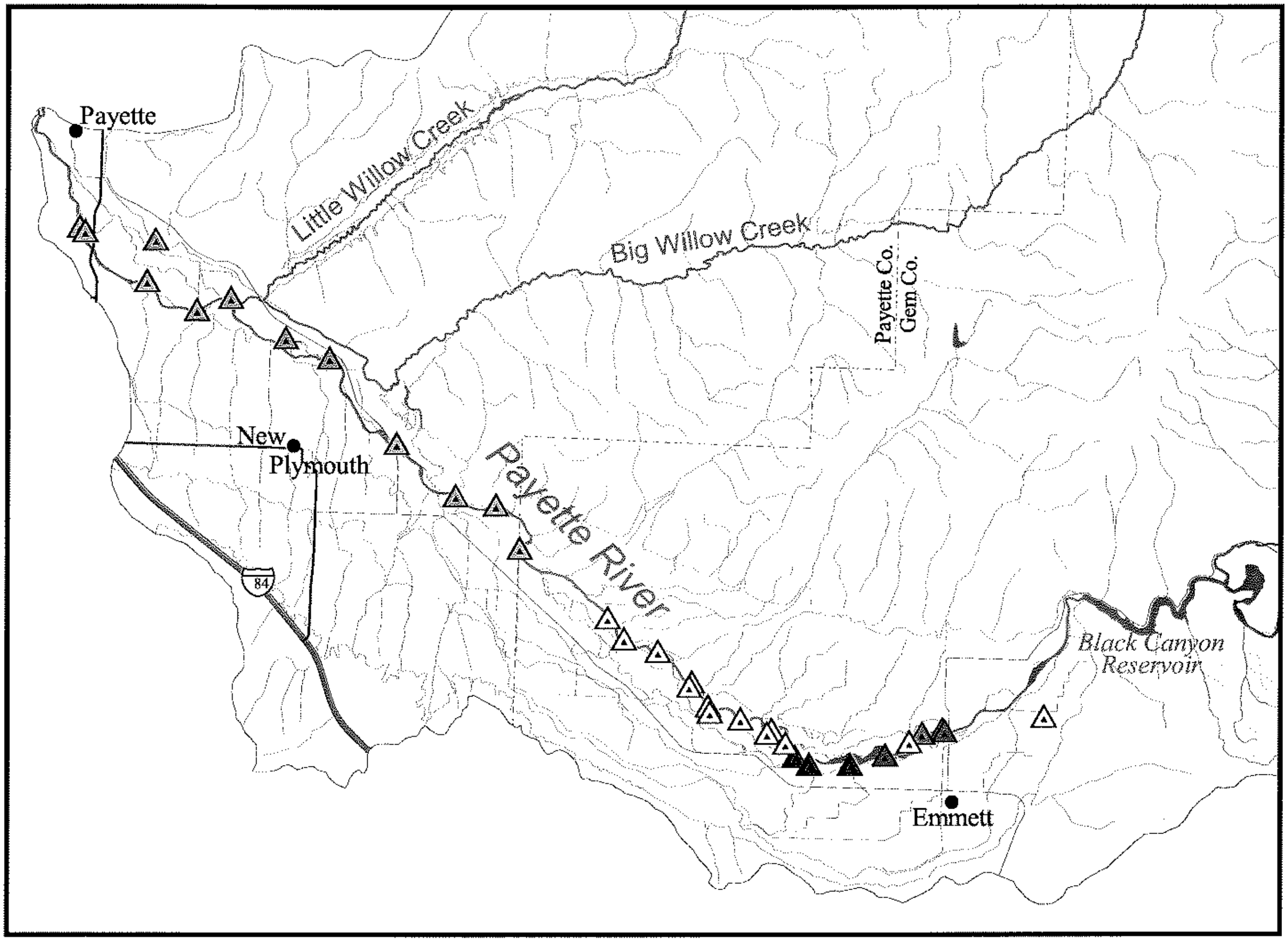
The Idaho Department of Water Resources Potential Hydropower Sites database was used to compile this table. The database was developed by using information from the sources listed below.

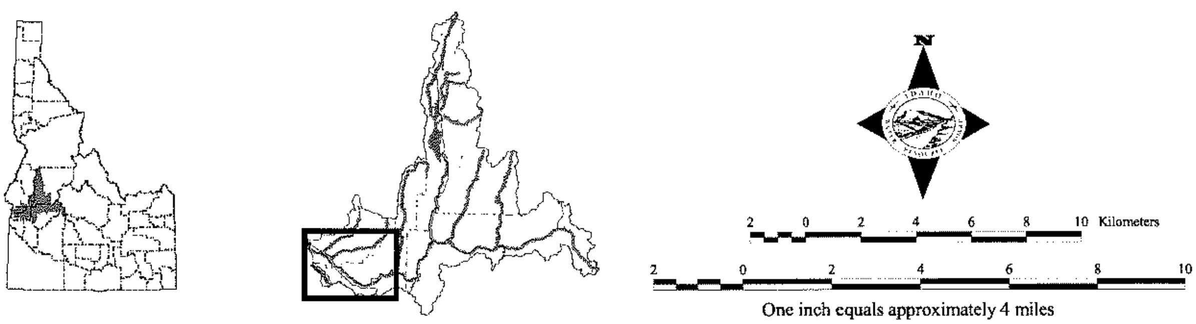
Sources: Idaho Department of Water Resources, 1976; U.S. Army Corps of Engineers, 1986; U.S. Bureau of Reclamation and U.S. Army Corps of Engineers, 1994; and U.S. Geological Survey, 1965.

Map 13. Levee Ownership

Owner

- Bilbury Ditch Co.
- City of Emmett
- Payette County
- Natural Resources Conservation Service
- Gem County
- Lower Payette Ditch Co.





y:\payette\arcview\projects\projects2\struct.apr (8/16/98)

must adopt a floodplain ordinance that specifies land use measures in flood prone areas to avoid or reduce future flood damage. The Federal Emergency Management Agency that administers the National Flood Insurance Program has established minimum standards for participating cities and counties.

Floodplain ordinance requirements include elevating the lowest floor of a structure constructed in the 100-year floodplain at or above the base elevation of the 100-year flood. (The 100-year floodplain includes lands subject to a 1 percent or greater chance of flooding in any given year.) Sanitary systems and water supply systems located in the 100-year floodplain must be designed to minimize or eliminate infiltration of flood waters. Development must not encroach into the floodway and must not increase flood levels. (The floodway is an area immediately adjacent to a river or stream channel which becomes the enlarged stream or river channel during flooding.) The participating county or community is responsible for enforcing floodplain ordinance requirements, and determining that other required federal, state, and local permits have been obtained before issuing a development permit.

Participation in the National Flood Insurance Program makes flood insurance available to property owners. Any mortgage, loan, grant, or other funding provided, insured, or regulated by a federal agency for a structure located in the floodplain must purchase flood insurance by law. Many lenders may also require flood insurance for conventional loans.

The Federal Emergency Management Agency conducts studies and prepares maps depicting flood hazard information. These maps identify boundaries of the 100-year floodplain and the floodways. Floodplain mapping was completed for Gem County in 1978, Payette County in 1984, Boise County in 1988, and Valley County in 1990.

HYDROPOWER DEVELOPMENT

Existing and Historic Development

Hydropower facilities currently operating in the Payette River Basin are summarized in Table 20. Cascade Power Plant, owned by Idaho Power Company, is located on the North Fork Payette at Cascade Dam. A hydropower facility was originally constructed in 1926 by the Wood River Power Company near this location prior to Cascade Dam (Holt, 1935). In the same year West Coast Power Company acquired the project. Idaho Power Company later purchased the West Coast Power Company in 1944 (Young and Cochrane, 1978).

The current power plant located at the Cascade Dam was constructed in 1984 by Idaho Power Company (Federal Energy Regulatory Commission License No. 2848). The generating plant includes two Kaplan turbines which can divert a combined total of about 2,300 cubic feet per second (Boyles, 1997). Idaho Power Company holds a natural flow water right of 200 cubic feet per second that is senior to the storage water right at Cascade Reservoir. Inflows up to 200 cubic feet per second are required to be released from the dam year-round.

Table 20. Existing Hydropower Development in the Payette River Basin.

Facility	Location	Capacity (MW)	Owner
Cascade	North Fork Payette	12.8	Idaho Power Company
Horseshoe Bend	Main Payette	9.5	Horseshoe Bend Hydroelectric Company
Black Canyon	Main Payette	8.0	U. S. Bureau of Reclamation

Average annual generation is 47,000 megawatt-hours (megawatt-hours = 1,000 kilowatt-hours).

The Horseshoe Bend Power Plant, owned by Horseshoe Bend Hydroelectric Company, is located on the main Payette River. The project consists of a diversion dam located at the east edge of Horseshoe Bend, and a 3-mile power canal that crosses the town to the power plant located downstream. In 1902 the Boise-Payette River Electric Power Co. built a hydropower project at this location which operated until 1954 (See Table 21). The original project consisted of a diversion structure and power canal with 1.0 megawatt of capacity (later enlarged to 1.5 megawatts) (Holt, 1935). The plant was constructed to augment an 180 kilowatt plant built in 1887 off the Ridenbaugh Canal in Boise for use in Boise (Young and Cochrane, 1978).

The current Horseshoe Bend Project was licensed by the Federal Energy Regulatory Commission (License No. 5376) in 1986 and constructed in 1995. Facility operation entails a minimum bypass of 420 cubic feet per second into the river, and a diversion of up to 3500 cubic feet per second when available (Buchanan, 1997). The 9.5 megawatt capacity of the hydropower facility involves two units rated at 5.9 megawatts and 3.6 megawatts, each with a maximum head of 48 feet (See water permit number 65-12563). Average annual generation is 53,000 megawatt-hours.

The Black Canyon Power Plant, built by the U. S. Bureau of Reclamation in 1925, is located at Black Canyon Dam about 4 miles upstream from the town of Emmett. The power plant supplies power for the Boise Project canal relift pumps, the Owyhee and Minidoka Projects, and other public and private consumers outside the basin as part of an exchange agreement with Idaho Power Company. The 8.0 megawatt powerplant has two 4.0 megawatt generating units, with a maximum peaking capability of 10.2 megawatts. Total turbine capacity is 1,600 cubic feet per second (See water right licenses no. 65-02288 for 1,300 cubic feet per second and 65-09481 for 300 cubic feet per second). Average annual generation is 78,000 megawatt-hours. In addition, two 625 horsepower direct-connected turbine driven pumps are located in the powerhouse to serve the Emmett Irrigation District's canal on the north side of the river.

Several hydropower facilities operated in the basin, but are no longer in existence. These are listed in Table 21, and briefly described below. Two were located in the North Fork Payette Subbasin - one on

Table 21. Historic Hydropower Sites Developed in the Payette River Basin - No Longer Operating.

Project Name	Location	Capacity (MW)	Comments
North Fork Payette Subbasin			
McCall	Lake Fork	0.03	Constructed in 1918
Cascade	North Fork Payette	0.3	Constructed 1926 before Cascade Dam
South Fork Payette Subbasin			
Lowman	Clear Creek	0.03	Constructed in 1940
Statton Ck / Deadwood Lodge	Statton Creek	0.15	Constructed in 1924
Deadwood	Deadwood River	0.375	Constructed in 1928
Grimes Pass	South Fork Payette	1.22	Constructed in 1904
Main Payette Subbasin			
Horseshoe Bend Project	Main Payette	1.0*	Constructed 1902, operated until 1954

*Later expanded to 1.5 megawatts

Sources: Holt, 1935; Colbert, 1966; Young and Cochrane, 1978; Murray, 1990.

the Lake Fork and a small powerplant located near Donnelly on the North Fork.

Several facilities were constructed in the South Fork Payette Subbasin. A household generator on Bear Creek, a tributary to the South Fork near Grandjean, was issued a Federal Energy Regulatory Commission License (No. 1385) in 1936 (Holt, 1935). The Statton Creek Power Plant (Federal Energy Regulatory Commission License No. 568) was constructed for use in the Deadwood mines by the Bunker Hill & Sullivan Mining & Concentrating Company, and subsequently served the Deadwood Lodge. The Deadwood Power Plant, constructed on the Deadwood River, was also constructed by the Bunker Hill & Sullivan Mining & Concentrating Company for use by the Deadwood mines. The Lowman Hydropower Project (Federal Energy Regulatory Commission License No. 1808) was located on Clear Creek (Colbert, 1966). The Grimes Pass Power Plant was constructed on the South Fork Payette River just above Garden Valley by the Centerville Dredging Company. This powerplant was rebuilt in 1909 by the Boston & Idaho Gold Dredging Company, later selling the project to the Grimes Pass Power Company in 1926 (Murray, 1990). The electricity was used for dredge mining and municipal purposes in the Boise Basin (Idaho City vicinity) (Holt, 1935). Construction of Deadwood Reservoir in 1931 with 162,000 acre-feet of active storage significantly reduced the water available for power production during all but the summer months.

Potential Hydropower Development

Table 22 summarizes hydropower development opportunities that have been identified in the basin without considering economic or environmental feasibility. Most of these sites are identified in a report prepared by the Idaho Water and Energy Resources Research Institute. This report compiled information about hydropower development opportunities that were listed in more than 24 reports prepared by government and private entities (Warnick, et al., 1981).

The South Fork Payette has an average gradient of 35 feet per mile, with some reaches near 60 feet per mile. The lower reach of the South Fork Payette possesses better sites for dam construction, because greater volumes of water are available. Many of the South Fork Payette tributaries have steep gradients, making the available energy significant despite the small quantities of water. Some hydropower development sites have been identified in the Main Payette Subbasin (See Table 22).

The most recent project investigated in the South Fork Payette Subbasin was located near the mouth of the Deadwood River. An application was filed by Intermountain Power Corporation for the Oxbow Bend Hydroelectric Project (Federal Energy Regulatory Commission No. 6329) in 1984. The project proposed to use a 1,000-foot long tunnel previously constructed for hydraulic mining. The Board designated the reach a state recreational river in 1991, prohibiting hydropower construction. In 1992 the Federal Energy Regulatory Commission denied the application, because the Forest Service found the river reach eligible for further study as a National Wild and Scenic River, which precludes hydropower development in the interim.

Several very small power projects also have been studied throughout the basin; however, construction is not known to have started on any project. Many of these projects are located in the upper watersheds and proposed by individual property owners. The relief in the basin provides an opportunity for many similar projects.

Table 22. Hydropower Sites Investigated in the Payette River Basin.

Project	Site	Capacity (MW)	Comments
North Fork Payette Subbasin			
Upper Lake	North Fork Payette	3.2 / 1.4	Hydropower potential identified at existing site
Upper Payette Lake	North Fork Payette	0.4	Hydropower potential identified at existing site
Payette Lake	North Fork Payette	0.3	Hydropower potential identified at existing site
Browns Pond	Lake Fork	1.9	Hydropower potential identified at existing site
Little Payette Lake	Lake Fork 1.0		Hydropower potential identified at existing site
Sugarloaf	North Fork Payette	111.0	Offstream reservoir or diversion w/hydropower potential
Sugarloaf Tunnel	North Fork Payette	200.0	Offstream reservoir or diversion w/hydropower potential
Horsethief Basin	Big Creek	1.4	Tributary to North Fork Payette
Alpha	North Fork Payette	7.6	
Bogus Creek/Cabarton	North Fork Payette	13.5 / 60.7	
Clear Creek	Clear Creek	2.1 / 37.6	Tributary to North Fork Payette
Upper Squaw Creek	North Fork Payette	90.0	Offstream reservoir or diversion w/hydropower potential
Squaw Creek Upper Tunnel	North Fork Payette	200.0	Offstream reservoir or diversion w/hydropower potential
Lower Squaw Creek	North Fork Payette	57.5	Offstream reservoir or diversion w/hydropower potential
Squaw Creek Lower Tunnel	North Fork Payette	215.0	Offstream reservoir or diversion w/hydropower potential
Middle Fork Payette	North Fork Payette	139.9	Offstream reservoir or diversion w/hydropower potential
North Fk to Mid Fk Tunnel	North Fork Payette	72.0	Offstream reservoir or diversion w/hydropower potential
Tripod Creek	North Fork Payette	7.7	
Upper Smiths Ferry	North Fork Payette	7.3	
Middle Smiths Ferry	North Fork Payette	7.3	
Lower Smiths Ferry	North Fork Payette	7.3	
Ferncroft	North Fork Payette	174.0	Idaho Power Company received FERC license in 1982, relinquished in 1986.
Banks	North Fork Payette	99.0	Idaho Power Company received FERC license in 1982, relinquished in 1986.
Round Valley	North Fork Payette	350	Offstream reservoir or diversion w/hydropower potential
Banks Pumped Storage	North Fork Payette	500	Offstream reservoir or diversion w/hydropower potential
Banks	North Fork Payette	10.0	Most current proposal by Gem irrigation District
Upper Scriver	North Fork Payette	28.9	
Scriver Creek Unit	North Fork Payette	107.5	
South Fork Payette Subbasin			
Elk Lake	South Fork Payette	1.3 / 1.5	
Baron Creek	South Fork Payette	1.2 / 1.4	
Grand Jean	South Fork Payette	4.1 / 7.5	
Fogus	Canyon Creek	0.4 / 1.7	Tributary to South Fork Payette
Canyon Creek	South Fork Payette	2.4 / 8.5	
Bull Trout Lake	Warm Spring Creek	0.1	Hydropower potential identified at existing site
Casner Creek	South Fork Payette	3.5 / 50.7	
Eightmile Creek	Eightmile Creek	0.6 / 1.2	Tributary to South Fork Payette
Archie Creek	South Fork Payette	4.8 / 17.5 / 79.8	
Kirkham Hot Springs	South Fork Payette	1.6	
Steep Creek	South Fork Payette	4.9 / 25.6	
Lowman	South Fork Payette	2.9	
Oxbow Bend	South Fork Payette	26.1 / 93.7	
Oxbow Bend	South Fork Payette	30.0	FERC application filed in 1984, denied in 1992.
Pine Flat	South Fork Payette	14.1	Idaho Power relinquished FERC permit in 1981
Big Falls	South Fork Payette	6.6 / 28.1	Idaho Power relinquished FERC permit in 1981.
Big Pine	South Fork Payette	20.5 / 96.0	
Black Bear	South Fork Payette	16.1	Idaho Power relinquished FERC permit in 1981.
Grimes Pass	South Fork Payette	16.1	Idaho Power relinquished FERC permit in 1981.
Garden Valley	South Fork Payette	34.4 / 844	
Garden Valley Reregulating	South Fork Payette	64.0	
Garden Valley	South Fork Payette	285.2	
South Fk to Mid Fk Tunnel	South Fork Payette	29.0	

Project	Site	Capacity (MW)[1]	Comments
South Fork Payette Subbasin (continued)			
Cloverleaf	Deadwood	6.9 / 13.5 / 12.6	
Tranquil Basin	Deadwood	n/a	
Deadwood	Deadwood	0.1 / 6.4	
Deadwood Dam	Deadwood	7.0	
Scott Creek	Deadwood	5.2 / 6.9 / 56.9	
Josie Creek	Deadwood	2.8	
Slaughterhouse Creek	Deadwood	2.7	
Boiling Springs	Middle Fork Payette	1.1 / 3.7	
Peace Valley	Silver Creek	0.7 / 1.9	Tributary to Middle Fork Payette
Rocky Canyon	Middle Fork Payette	3.0 / 2.7	
Lower Scriver	Mid Fork tributary	48.5	
Middle Fork Payette	Middle Fork Payette	139.9	Offstream storage site with hydropower potential
Main Payette Subbasin			
Dry Buck	Payette	13.5	
Gardena	Payette	11.7	
Porter Creek	Payette	8.0	
Horseshoe Bend	Payette	49.7 / 501.9	
Sage Hen	Sage Hen Creek	0.2	Tributary to Squaw Creek
Montour Valley	Payette	16.0 / 56.0	
Black Canyon Diversion	Payette	64.0	
Black Canyon Upgrade	Payette	10.0	Hydropower potential identified at existing site
Paddock Valley	Little Willow Creek	1.2	Hydropower potential identified at existing site

[1] Sites with more than one capacity listed indicate that several project configurations have been identified.
Sources: Warnick, et al., 1981; U.S. Bureau of Reclamation, 1986; Gem Irrigation District, 1990; Myers, 1995.

Proposed North Fork Payette Hydropower Project

Projects pursued by private individuals are reviewed and licensed by the Federal Energy Regulatory Commission. Several projects have been licensed or issued permits for study in the past. The only hydroproject currently pursued in the basin is proposed for the North Fork Payette between Smiths Ferry and Banks. The steep river gradient of 112 feet-per-mile make this an attractive site for hydropower development. Several configurations have been proposed over the years.

The U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers suggested development at various times between 1961 and 1977 (U.S. Bureau of Reclamation and U.S. Army Corps of Engineers, 1961; U.S. Bureau of Reclamation, 1977). In 1982 Idaho Power Company obtained a Federal Energy Regulatory Commission license to develop 316.0 megawatt project on two river reaches totaling 1,385 feet of head (known as the Banks and Ferncroft projects). The diversion was located below Smiths Ferry with an 11-mile tunnel and penstock discharge. In 1986 Idaho Power Company requested a termination of the license, because construction costs and energy needs did not justify its development.

In 1988 the Gem Irrigation District received a Federal Energy Regulatory Commission permit to study a project on the same river reach. The original project proposed diverting water from the North Fork Payette between Cabarton Bridge and Smiths Ferry to an offstream re-regulating reservoir in Round Valley. Water would drop through a tunnel into a power plant approximately one-half mile below Smiths Ferry. A second intake below the first power plant would again drop water through a 65,000-foot gravity tunnel to a second power plant at Banks. In an attempt to address public concerns, a second proposal was made in 1990. The Banks Pumped Storage Project proposed to pump water from the North Fork Payette below Smiths Ferry into High Valley to the west. The water would drop from High Valley to an underground power plant near Banks.

Gem Irrigation District has further modified its proposal. The current hydropower project proposal involves diverting water downstream of Smiths Ferry into a 4-foot diameter steel pipeline, approximately 13 miles in length, buried beneath the Idaho Northern and Pacific railroad bed. A powerhouse would be located 2.5 miles upstream from Banks installed with a single, horizontal-shaft, Pelton turbine, connected to a 10 megawatt generator. Project operation would entail diversion of up to 100 cubic feet per second from the river downstream of Smiths Ferry, while maintaining a 200 cubic feet per second bypass flow. The project could operate with flows ranging from a maximum of 100 cubic feet per second to a minimum of 10 cubic feet per second. This current proposal is not under an active Federal Energy Regulatory Commission permit, and has not been granted a water right.

Hydropower Potential at Existing Dams

The Board prefers that new hydropower resources be developed at dams having hydropower potential that do not currently generate power or do not generate at their maximum potential (Idaho Water Resource Board, 1996; See Policy 4E). Several opportunities may be available in the Payette River Basin. One proposed at Payette Lake Outlet was investigated by the Payette Power Company in 1994. The project is not currently being pursued.

The possibility of adding hydropower capabilities to Deadwood Dam has been considered. The U.S. Bureau of Reclamation has determined that this is not economically feasible, because of transmission costs (Jarsky, 1997). The U.S. Bureau of Reclamation has also investigated the potential to expand power generation at Black Canyon Dam. The study determined that a 10 megawatt generating capacity could be added to the existing facility (U.S. Bureau of Reclamation, 1986). Although feasible from a technical and water availability standpoint, construction costs could not be recouped with current energy surpluses and prices (Jarsky, 1997). Changes in energy supply/demand and deregulation may make the project economically feasible in the future.

WATER QUALITY

SURFACE WATER QUALITY

The Idaho Division of Environmental Quality in *The 1994 Idaho Water Quality Status Report* summarized water quality concerns for the Payette River Basin. Minor impacts from timber management and mining were cited on the North Fork Payette above Payette Lake, but subsequent beneficial use reconnaissance indicated that all uses were fully supported. The water quality of Payette Lake was described as excellent. Cascade Reservoir was cited as a special state concern. Many activities contributed to the reservoir's water quality problems, including the shallow depth and size of the waterbody. Livestock grazing, timber management, and impacts from roads were cited as water quality concerns on the North Fork Payette below Cascade Reservoir, the South Fork Payette, the Middle Fork Payette, and the main Payette to Black Canyon Reservoir. Impacts from irrigated crop and pasture lands were additional concerns on the main Payette to Black Canyon Reservoir. Nutrients, bacteria, and temperature problems have led to designation of the Payette River below Black Canyon Reservoir as water quality limited.

Water Quality Limited Water Bodies

In 1996 the Environmental Protection Agency, under the authority of the Federal Clean Water Act, released a 303(d) list which identified 962 water quality limited waterways in Idaho. The 39 water quality limited waterbodies located in the Payette River Basin and the pollutant(s) of concern are identified in Table 23 and depicted in Map 14. Water quality limited waterbodies are those not currently meeting applicable water quality standards for specific designated beneficial uses (Zaroban, 1993). Beneficial uses for water quality standards include, but are not limited to, domestic water supply, agriculture, navigation, recreation in and on the water, wildlife habitat, and aesthetics [IDAPA 16.01.02003,01].

Water quality limited designations under Section 303(d) require that the U.S. Environmental Protection Agency develop total maximum daily load (TMDL) plans. These plans are designed to restore the impaired waterbodies to compliance with water quality standards through establishment of load allocations (nonpoint sources) and waste load allocations (point sources). Two waterways in the basin are high priority for total maximum daily load plan development -- Cascade Reservoir and the Payette River from Black Canyon Dam to the Snake River. The remaining water quality limited waterways are low priority, indicating that designated uses are not fully supported, but risks to human health, aquatic life, recreation, economics, or aesthetics are minimal. The status of total maximum daily load plans for the Payette River Basin is described further in the *Institutional Constraints and Opportunities* section.

Special Resource Waters

The Idaho Legislature may designate waterbodies as Special Resource Waters with the intent of protecting beneficial uses against further degradation by point source pollution. Special Resource Waters are specific water bodies needing intensive protection to preserve either outstanding or unique characteristics, or to maintain a designated beneficial use (Zaroban, 1993). New discharge sources are allowed only if water quality of the receiving water remains unchanged. Map 14 depicts the eight basin waterbodies designated as Special Resource Waters.

Water Quality Summaries

<u>North Fork Payette Subbasin</u>

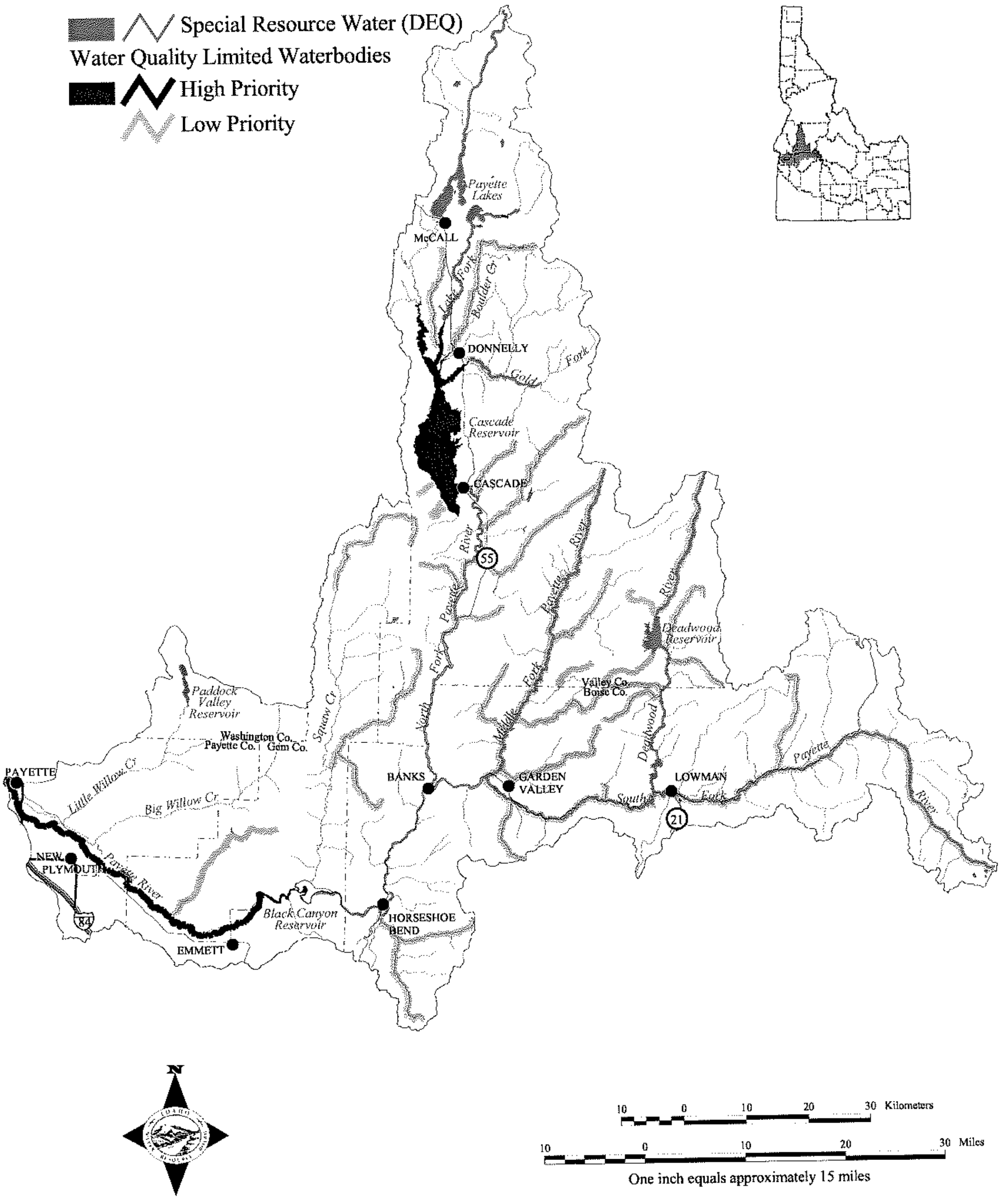
North Fork Payette: Headwaters to Payette Lake Outlet -- According to *The 1994 Idaho Water Quality Status Report,* streams above Payette Lake contribute small amounts of sediment and nutrients from timber management activities and mining, but all beneficial uses were still fully supported (Idaho Division of Environmental Quality, 1994). A recent Payette National Forest study found that human-caused pollution sources to Payette Lake include roading, logging, home building, and recreation (Weaver, 1995). Recreation and residential development contribute sediment, human waste, garbage, detergents, oils, and fuels to the rivers and lakes.

Table 23. Payette River Basin Waterbodies on the Environmental Protection Agency's 1996 Idaho 303(d) List.

Waterbody / Reach	Pollutants
HIGH PRIORITY	
Cascade Reservoir	nutrients, pathogens, dissolved oxygen, pH
Payette River - Black Canyon Dam to Snake River	nutrients, bacteria, temperature
LOW PRIORITY	
North Fork Payette Subbasin	
North Fork Payette - Clear Creek to Smiths Ferry	nutrients, sediment, temperature modification, flow alteration, habitat alteration
Alder Creek	sediment
Beaver Creek	sediment
Big Creek	sediment
Boulder Creek	nutrients, sediment, dissolved oxygen, temperature modification, flow alteration
Browns Pond	habitat alteration
Campbell Creek	sediment
Clear Creek	sediment
Fawn Creek	sediment
French Creek	sediment
Gold Fork River - Flat Creek to Reservoir	nutrients, sediment
Hazard Creek	sediment
Mud Creek	nutrients, sediment, dissolved oxygen, pathogens, ammonia
Round Valley Creek	sediment
South Fork Payette Subbasin	
South Fork Payette River - Headwaters to Banks	sediment
Deadwood River - Above Deadwood Reservoir	sediment
Middle Fork Payette River	sediment
Anderson Creek	sediment
Basin Creek	sediment
Big Pine Creek	sediment
Bulldog Creek	sediment
Eightmile Creek	sediment
Lightning Creek	sediment
Ninemile Creek	sediment
Scott Creek	sediment
Scriver Creek	sediment
Silver Creek	sediment
Trail Creek	sediment
Whitehawk Creek	sediment
Wilson Creek	sediment
Main Payette Subbasin	
Bissel Creek	sediment
Black Canyon Reservoir	nutrients, sediment, oil/grease
Harris Creek	sediment
Little Squaw Creek	sediment
Shafer Creek	sediment
Soldier Creek	low dissolved oxygen
Upper Squaw Creek	sediment

Source: Environmental Protection Agency, 1996.

Map 14. Water Quality Designations



y:\payette\arcview\projects\projects2\designat.apr (8/18/98)

Motorized watercraft leak oil and gas into Payette Lake, and runoff from lawns along the lakeshore contribute fertilizer and pesticide contaminants. Timber harvesting and associated road building contribute sediment to tributary streams, while grazing is only a minor contributor of sediment.

Although Payette Lake water quality is generally considered good, concerns about degradation from population growth and watershed changes initiated a watershed project in 1992 by the Big Payette Lake Water Quality Council and community of McCall (Big Payette Lake Technical Advisory Committee, 1997). The Big Payette Lake Technical Advisory Committee reported that the Payette Lake water quality had progressively deteriorated because of eutrophication. Tributaries to the lake as well as the development around the lake are nutrient sources. Phosphorus and sediment loadings were found to be higher in 1995 and 1996 after 50 percent of the watershed burned in 1994. Roads were reported to contribute sediment to streams, affecting Upper Payette and Payette lakes. Storm runoff contributing sediment, nitrogen, and phosphorus from the urban/residential areas around Payette Lake was found to be a larger contributor than the tributary streams. Upper Payette Lake was found to be an important sink for nutrients and sediments that may otherwise move on to Payette Lake.

A 1995-96 U.S. Geological Survey study found Payette Lake is still oligotrophic (low in nutrients and biological productivity), but the lake has recently developed an anoxic (no oxygen) condition in the southwest end during the summer and autumn. The condition was more extensive than predicted by nutrient loads (Woods, 1997a). This condition is believed to have progressively developed as nutrient loads increased over the years. The lake has retained 54 percent of its influent load of nitrogen and 79 percent of influent phosphorus, primarily as accumulated lakebed sediments. Phosphorus is largely contributed by the North Fork Payette (58 percent), with the remainder from surface runoff and other tributaries around the lake. Woods concludes that the anoxic condition would be unresponsive to reduced nutrient loading, but a goal should be to prevent an increase in phosphorus loading to the lake.

About 450 tons of sediment (20-35 percent of the total to the lake) is delivered to Payette Lake from management-related activities each year, primarily road erosion. The sediment and phosphorus loading has resulted in aquatic macrophyte production with nine genera observed in the lake's littoral areas. The presence of eurasian milfoil (*Myriophyllum spicatum* var. *spicatum*), a nuisance plant of special concern, received a positive taxonomic identification. Later DNA tests have showed inclusive results for identification (Woods, 1999).

North Fork Payette: Payette Lake Outlet to Cascade Reservoir Dam -- The Phase II Cascade Reservoir Watershed Management Plan identifies major point and nonpoint pollution concerns (Idaho Division of Environmental Quality, 1998). Two point sources of pollution contributing nutrients and other constituents to the reservoir were McCall's wastewater treatment facility and the Idaho Department of Fish and Game's fish hatchery. Both discharged wastewater into the North Fork Payette River above the reservoir.

Development of the J Ditch irrigation pipeline project eliminates discharge of McCall's wastewater into the North Fork Payette River. The J Ditch carries the effluent to irrigators, replacing water diverted from Mud Creek and Lake Fork Creek. This project relied on land application of treated wastewater on agricultural lands near McCall for the first time in

1998. Currently the project is operational during the irrigation season, until cells are completed to store waste water in the off-season.

Several nonpoint pollution sources affect Cascade Reservoir, including forest management and agricultural practices, urban/suburban runoff, nutrient-enriched ground water, shoreline erosion, and internal nutrient recycling. Summaries of these sources are contained in the watershed management plan (Idaho Division of Environmental Quality, 1998).

Phosphorus loading is the main concern for Cascade Reservoir. Combined point and nonpoint contributions are summarized in Figure 28. Agriculture contributes a high proportion of phosphorus, while urban/suburban sources contribute a small percentage. Contributions from the McCall wastewater treatment plant would be eliminated with completion of the J Ditch. Natural internal recycling is a significant contributor, and combined with precipitation, accounts for just over one-quarter of the total load.

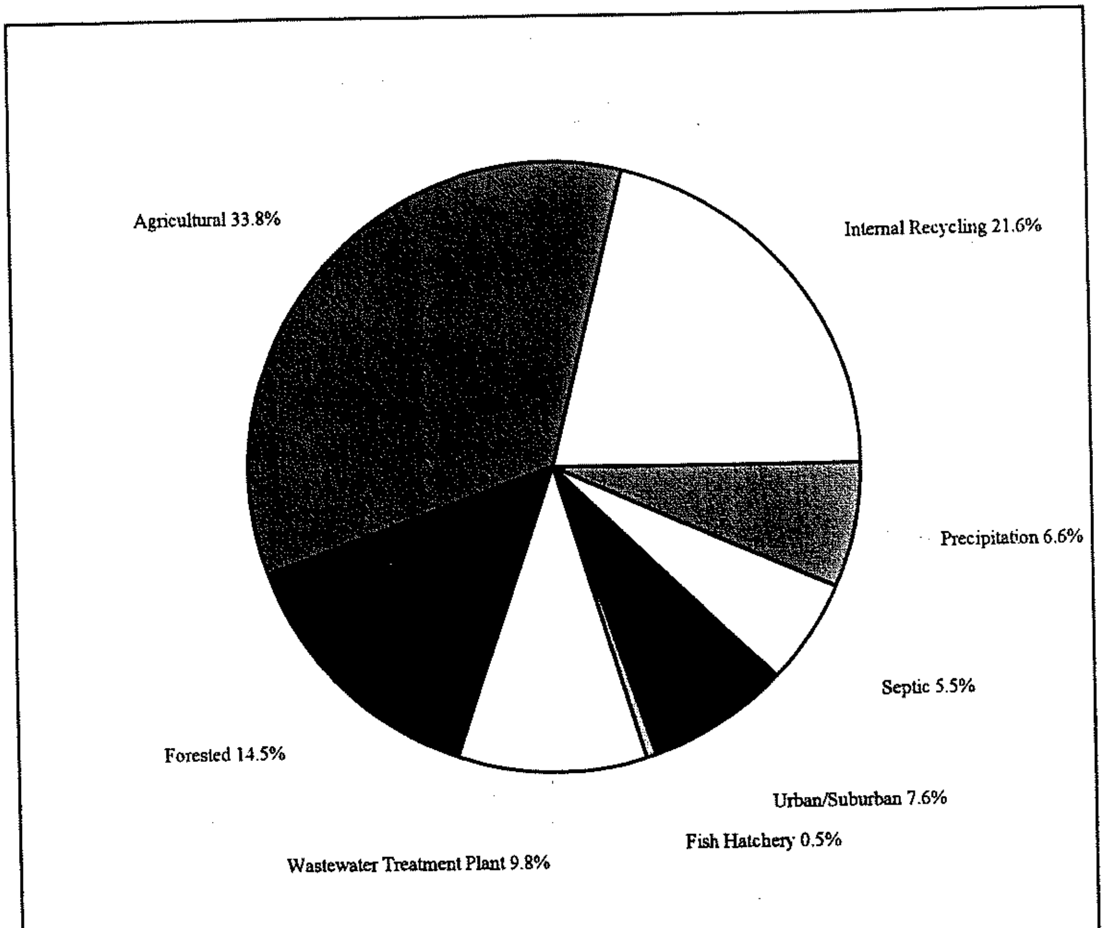


Figure 28. Phosphorus Loading in Cascade Reservoir (Idaho Division of Environmental of Quality, 1998).

Major Cascade Reservoir tributaries (Mud Creek, Boulder Creek, Willow Creek, and Gold Fork River) flowing through irrigated pasture land and degraded riparian areas contribute phosphorus and sediment to the reservoir (Idaho Division of Environmental Quality, 1998). Sediment is also contributed by timber management activities in the tributary drainages. Boulder Creek, Browns Pond (Lake Fork), Gold Fork River, and Mud Creek are all listed as water quality limited by the Environmental Protection Agency (Table 23, page 79). Several agencies and entities are involved in land management activities to address these concerns.

The Boise National Forest is involved in rehabilitation projects in the Gold Fork watershed to reduce surface erosion through riparian set-backs, road surfacing, and special timber harvest techniques. Boise Cascade Corporation, in cooperation with federal and state agencies, has completed a large-scale soil and phosphorus contribution analysis for the Gold Fork watershed (Boise Cascade Corporation, 1996). State Agricultural Water Quality Projects have occurred in the Boulder, Willow, and Mud Creek watersheds. A riparian demonstration project in the Boulder Creek drainage is improving grazing practices to demonstrate improved water quality and phosphorus reductions. The Valley County Soil and Water Conservation District is instrumental in the implementation of the J Ditch project. In addition to eliminating discharge of McCall wastewater into the North Fork Payette, the J Ditch resulted in the conversion of flood irrigated lands to more water efficient sprinkler irrigation in the Mud Creek watershed.

North Fork Payette: Cascade Reservoir Dam to Banks -- Eleven waterbodies or river reaches are considered water quality limited within this subwatershed, including the North Fork Payette from Clear Creek to Smiths Ferry, which is listed for nutrients, sediment, temperature modification, flow alteration, and habitat alteration (Table 23, page 79). Sediment is the single pollutant identified in the remaining ten waterbodies. According to the Idaho Department of Fish and Game, sediment, high water temperatures, and low flows have likely impaired the fishery in the North Fork Payette from Cascade Dam to Smiths Ferry (Anderson, 1996).

South Fork Payette Subbasin

Few water quality studies have been done on the South Fork, Middle Fork, and Deadwood River watersheds, but several of their tributaries have received Beneficial Use Reconnaissance Project monitoring. This monitoring program was started in 1993 by the Division of Environmental Quality on Idaho streams identified as water quality limited under Section 303(d) of the Federal Clean Water Act (Idaho Division of Environmental Quality, 1996). Sixteen water bodies are designated as water quality limited by the Environmental Protection Agency, with sediment being listed as the pollutant of concern (Table 23, page 79).

South Fork and Middle Fork Payette Rivers -- Prior to Black Canyon Dam construction in 1923, the South Fork Payette and Middle Fork Payette were excellent anadromous fish streams with large runs of chinook and steelhead (Payette Soil & Water Conservation District, 1993). Currently, the water quality is adequate to support bull trout, wild rainbow trout, and mountain whitefish (Grunder, 1991). Granitic rock and shallow, unstable soils have contributed considerable amounts of sediment from the steep slopes in the South Fork watershed, resulting in some degradation of water quality. Current Beneficial Use Reconnaissance Project monitoring in this area will provide information to determine the beneficial use status in the future.

Deadwood River: Headwaters to South Fork Payette River -- A Forest Service ecosystem analysis of Deadwood Reservoir tributaries indicated that sedimentation rates into the reservoir were low (U.S. Forest Service, no date). Forest Service water quality assessments for tributaries, including Trail Creek, Moulding Creek, and South Fork Beaver Creek, indicated normal background sediment contributions.

A 1983 study of Idaho lakes identified Deadwood Reservoir as a moderately productive, or oligo-mesotrophic, water body (Milligan, et al., 1983). The U.S. Bureau of Reclamation (1985) found water quality at Deadwood Dam good. Dissolved oxygen exceeded minimum standards (6 parts per million) for coldwater biota and salmonid spawning throughout the year (U.S. Bureau of Reclamation, 1985). A water quality study conducted in 1993 to 1994 had similar findings (Allen, et al., 1996). The study concluded water quality parameters had not changed significantly from those identified in a study conducted 30 years earlier. Late season oxygen reduction occurred in the reservoir below the 15 meter depth, but not enough to limit salmonid growth and survival. The study also concluded that removal of 20,000 acre-feet of water in the late season for salmon flow augmentation would have little impact on oxygen levels. Game fish populations were not impacted by water level reductions below the minimum conservation pool (50,000 acre-feet).

The U.S. Forest Service ecosystem analysis of Deadwood Reservoir and Deadwood River found sedimentation rates from tributaries below the dam much higher than those above, which is inconsistent with the water quality limited designation (U.S. Forest Service, no date). Little is known about the water quality of the Deadwood River below the reservoir, in large part because of it's inaccessibility, but it is generally considered to be very good (Ingham, 1997).

Main Payette Subbasin

Intensive water quality investigations have not occurred for the Payette River upstream of Black Canyon Reservoir (Thornton, 1997; Ingham, 1997).

Payette River: Black Canyon Reservoir Dam and tributaries -- In 1973, fifty years after construction of Black Canyon Dam, silt had filled one-third of the original pool (almost the total upper end of reservoir). The U.S. Bureau of Reclamation found fish habitat conditions for warmwater species fair to poor in Black Canyon Reservoir (U.S. Bureau of Reclamation, 1984). Silt-free shoreline areas are lacking, although a stable water level allows for development of benthic species for fish forage. Few areas of abundant vegetation exist to control shoreline water temperature and provide woody debris for fish habitat.

The Division of Environmental Quality evaluated beneficial uses for Squaw Creek in 1993, a tributary to the reservoir (McIntyre, 1993). The study reported cumulative impacts from combined timber harvest and grazing activities. Wild trout were present, but the author noted that the stream was deteriorating and lacked adequate rearing habitat for salmonids. An investigation of agricultural impacts on beneficial uses of Squaw Creek found the lower reach was moderately impacted by sediment, phosphorus, and high temperature (Kerpa, 1995). The most substantial impacts to the beneficial uses were temperature exceedences for coldwater biota and salmonid spawning.

Payette River: Black Canyon Dam to Mouth -- A 1985 study concluded water quality was good immediately below Black Canyon Dam (U.S. Bureau of Reclamation, 1985). However, dissolved solids, nutrients, and bacteria concentrations cumulatively increased downstream, attributed largely to irrigation return flows and municipal wastewater from Emmett.

In 1993 the Payette Soil and Water Conservation District identified major pollutants in the lower ten miles of the river (Payette Soil & Water Conservation District, 1993). Agriculture was cited as the predominant pollutant source, with more than 90 percent of sediment originating from surface irrigated cropland. Nitrogen loading was 1,219 pounds per day from cropland and feedlot runoff, while phosphorus loading to the river was 525 pounds per day. Both rates are typical for agricultural areas. Phosphorus concentrations in all agricultural drains were high, and many drains were found to carry high concentrations of fecal coliform bacteria. Fecal coliform counts ranged from 23.0 - 40,000 colonies per 100 milliters, with the majority originating from livestock.

Additional pollutant sources identified include septic systems, municipal sewage treatment facilities, land waste applications, and applications of nutrients and pesticides to urban areas. Several pesticides were detected in water samples, bottom sediment, and fish collected by the U.S. Geological Survey and U.S. Fish and Wildlife Service in 1990 (Payette Soil and Water Conservation District, 1993). Most were from the organochlorine group (e.g., DDD, DDE, DDT, dieldrin, and toxaphene), which are no longer in widespread use. Concentrations found in the fish were in excess of the dietary concentrations that impact bird reproductive success.

From their 1993 study, the Payette Soil and Water Conservation District identified critical areas in the Lower Payette. Critical areas are sources of agricultural nonpoint pollution that have the most significant impact on the water quality. Surface irrigated cropland, and dairies and feedlots were considered critical because of excessive sediment, nutrient, and bacteria contributions to the Payette River, and leachable nutrients and pesticides to the ground water. Irrigation return flow drains were also considered critical, because of excessive sediment and nutrient loading to the river. Irrigated pasture was not identified as critical, because it did not contribute significantly to total erosion and sedimentation. The Payette Soil and Water Conservation District is working with irrigators to minimize water quality problems in critical areas by implementing a number of best management practices.

From 1992 to1993, the Division of Environmental Quality studied agriculture return drains on the lower Payette River for sediments, nutrients, pesticides, and bacteria (Ingham, 1996). The data indicated that irrigated row crops contributed excessive amounts of nutrients, bacteria, and sediments to the river, and impacted designated beneficial uses. Dacthal, a fumigant pesticide, was detected in a selected number of drains during the non-irrigation season.

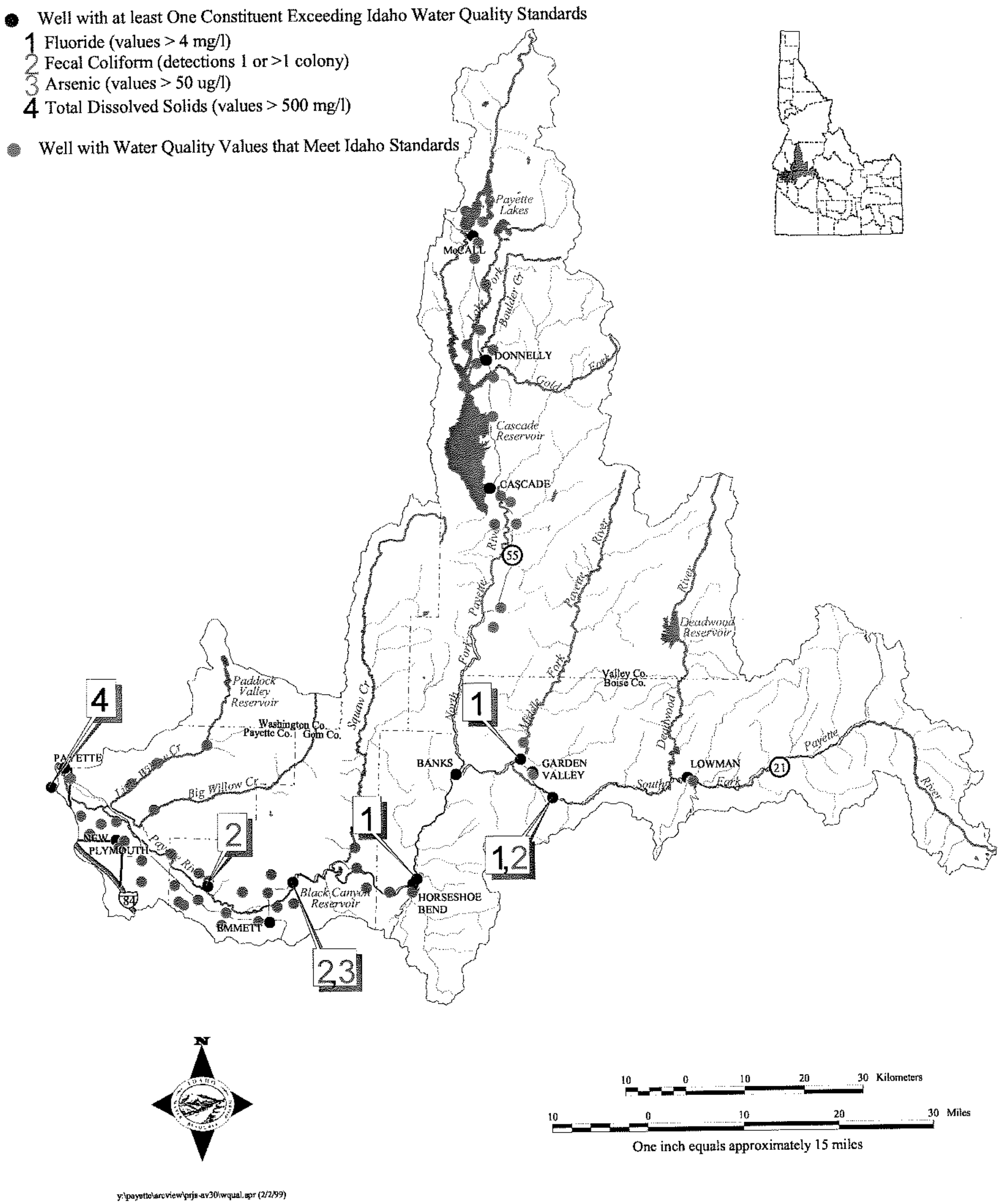
GROUND WATER QUALITY

The Idaho Ground Water Quality Monitoring Program, administered by the Idaho Department of Water Resources, provides random, ambient data for statistical analyses of ground water quality characterization, long term trends, and recognizing potential ground water quality problems. Maps 15 and 16 presents results of this program. The following section summarizes these and other data for ground water resources in the Payette River Basin.

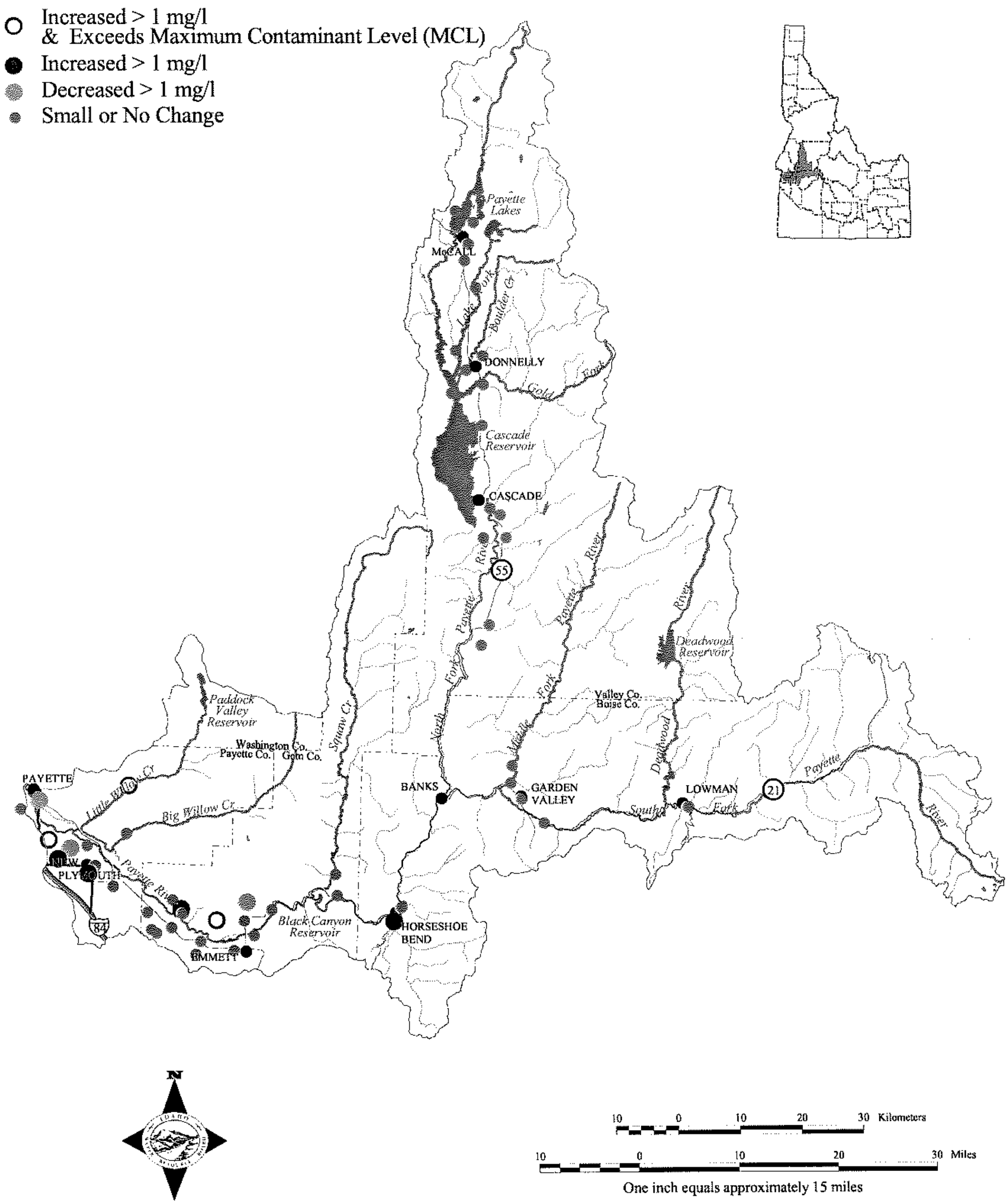
North Fork Payette Subbasin

Sampling in the Lake Fork-McCall area through the Statewide Ground Water Monitoring Program has found mildly elevated nitrate levels (4.0 milligrams per liter or less) in several wells (Crockett, 1997). Two-thirds of the sites tested in Valley County had elevated levels of iron and manganese. None of the constituents were present at levels that exceeded state water quality standards.

Map 15. Results from the Statewide Ambient Ground Water Monitoring Program



Map 16. Nitrate Changes from the Statewide Ambient Ground Water Monitoring Program



y:\payette\arcview\prjs-av30\wqual.spr (2/2/99)

South Fork Payette Subbasin

Sampling of wells for the Statewide Ground Water Monitoring Program has identified some wells in the Garden Valley area with fluoride levels exceeding Idaho water quality standards (See Map 15, page 86). Elevated fluoride levels can occur in areas with geothermal influences, despite cooler water temperatures (Neely, 1998). One well exceeded fecal coliform standards.

Main Payette Subbasin

Of the sites tested for ground water quality through the Idaho Statewide Ground Water Quality Monitoring Program, twenty-nine percent of the wells sampled had elevated nitrate concentrations (2.0 to 10.0 milligrams per liter), indicating impacts from land use activities. The majority of these sites were located in the Lower Payette River Valley. Map 16 (page 87) shows possible trends in nitrate concentrations for wells sampled between 1991 and 1994, and then sampled again four years later. A number of wells show a trend of increasing nitrate concentration, with several exceeding the maximum contaminant levels. Several wells show a decrease in nitrate concentration. These data indicate nitrate is impacting ground water quality in the lower Payette River area.

Some sampled wells exceeded state water quality standards for fluoride, fecal coliform, arsenic, and total dissolved solids (Map 15). Pesticides were also detected in a majority of the wells, but none of the detections exceeded primary maximum contaminant levels.

A study done in the early 1990s by the Division of Environmental Quality found that elevated nitrates occurred in ground water throughout the lower Payette Valley (Ingham, 1996). Some sampled wells exhibited high levels of nitrates, with several samples exceeding the 10 milligrams per liter primary maximum contaminant level standard. Thirty-eight pesticides were analyzed in this same study, and only Dacthal di-acid and 2-4-D were detected, neither in exceedence of safe drinking water criteria.

In 1993 the Lower Payette River Water Quality Planning Project reported on the ground water in the lower Payette Valley (Payette Soil & Water Conservation District, 1993). Secondary maximum contaminant levels for sulfate, iron, and total dissolved solids were exceeded in some of the sampled wells. Primary maximum contaminant levels protect against adverse health effects and are enforceable. Secondary maximum contaminant levels were established for aesthetic reasons such as taste and color, and are not enforceable.

Sulfates were greater than the 250 milligrams per liter secondary maximum contaminant level in 16 percent of wells sampled (Payette Soil and Water Conservation District, 1993). Iron exceeded the 300 micrograms per liter secondary maximum contaminant level in 25 percent of the wells sampled. Twenty-one percent of the sampled wells exceeded the secondary standard for total dissolved solids (500 milligrams per liter), with 10 percent exceeding the primary maximum contaminant level of 1000 milligrams per liter. The highest values for total dissolved solids (and nitrates) were obtained from shallow wells in heavily irrigated areas.

Reports of possible fecal contamination in 1996 resulted in a preliminary ground water study conducted in the Emmett area by the Idaho Department of Water Resources (Kellogg, et al., 1996). Of the fourteen wells sampled, three were contaminated with *Escherichia coli* possibly from animal wastes or a leaking septic system. All three were within fifty feet of each other. Follow-up actions were taken. The report recommended that central sewer and public water supply wells should be considered in the future.